ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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Works Manager Required, for London firm employing about 100 hands, and engaged in the manufacture of Boilers, Tanks, Pans, Bilges, Buoys, General Engineering, &c. Must have good knowledge of Electric and Mechanical Engineering; be a man with energy and tact, and able to turn out work expeditiously and cheaply. —Apply, with references, giving full particulars as to experience, stating salary, &c., O 276, Offices of ENGINEERING.

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Wanted, Immediately, by large firm (2000 hands) in North Midlands, experienced, capable MAN as Assistant Works Manager, to take control of cycle production on large scale. Highest post-war prospects. No one already employed on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 193.

Required Capable Man as Assistant for the Electrical and Engineering Section of the Buying Department of an important Company. Commencing salary £250. Reply, giving full particulars of experience and copy testimonials from past employers, to E. S. 878, care of DEACONS, Leadenhall Street, E.C. 3. O 282

Wanted Assistant Chemist with experience in the analysis of iron, steel, and non-ferrous alloys, for large works in the North of England. No one at present engaged on Government work need apply. Write stating age, experience and wage required to nearest EMPLOYMENT EXCHANGE, quoting No. A 6162. O 146

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Engineer of Methods, for Planning Department, REQUIRED immediately by controlled establishment, in London area, 2000 employees, for small and accurate repetition parts of electrical instruments. Electrical knowledge essential. Applicants must be first-class mechanics and be able to organise a growing department. Preference given to one with knowledge of piece rates. Only applicants having held a similar position need apply. No person already engaged on Government work need apply.—Apply, stating fully, experience, age, and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 6355. O 270

First-class Draughtsman REQUIRED, accustomed to Diesel or Semi-Diesel Engines, for large Engineering Works, Manchester district. No one on Government work will be engaged.—Apply, stating age, experience, and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 6166. O 40

Rate-Fixer wanted, thoroughly experienced, capable of starting up department in large factory (Birmingham district) making numerous products on manufacturing lines. Permanent and progressive position to suitable man.—Apply stating age, experience, salary desired to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 6295. O 335

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Accountant Wanted for London to take charge of Engineering Company's books, must be well versed in analysing and dissecting accounts. No one employed on Government work or living more than 10 miles away need apply. Write fully as to experience and salary required to O 309, Offices of ENGINEERING.

Wanted, Manager for engineering works. Must have practical experience with automatic, capstan and general repetition work. Must be good organizer. Knowledge of draughtsmanship an advantage. Good opening for energetic and capable man. No one at present engaged upon Government work or living more than 10 miles away need apply.—Address, stating references, O 310, Offices of ENGINEERING.

Salesman Wanted for South of England, one with technical knowledge of iron and steel trade preferred.—Must be first-class man.—Address, O 340, Offices of ENGINEERING.

Wanted, Thoroughly Qualified Mechanical DRAUGHTSMAN or Engineer. One having experience in Small Arms work preferred. — Apply by letter, ADMIRAL SLADE, 92, Victoria Street, S.W. 1. O 100

Draughtsmen Required, Experienced on medium or heavy Machine Tools, also one accustomed to Jigs, for Controlled works. Permanency to suitable men. No person already on Government work will be engaged.—Apply, stating full particulars, to your nearest EMPLOYMENT EXCHANGE, mentioning A 6143. O 91

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Good Mechanical Engineering DRAUGHTSMAN REQUIRED. No person already on Government work will be engaged.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 6350. O 273

Draughtsmen.—Two Jig and Tool Draughtsmen or Juniors WANTED. Must have shop experience. Apply, stating age, full particulars of experience and where obtained, also salary required. No person already on Government work need apply.—Apply, nearest EMPLOYMENT EXCHANGE, No. A 6214. O 193

Draughtsman Wanted for tools and jigs for engineering works in East Midlands. No one on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, quoting No. A 6224. O 197

Draughtsman, with Good aeronautical experience, REQUIRED for aeroplane factory, London district. No person resident more than 10 miles away or already on Government work need apply.—Address, stating age, full particulars of qualifications and salary required, O 206, Offices of ENGINEERING.

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Required, for Aeroplane factory, London district, MEN accustomed to ordering and setting operations in planning department. No person resident more than 10 miles away, or already on Government work, need apply.—Address, stating age, full particulars of qualifications and salary required, O 207, Offices of ENGINEERING.

Draughtsman Required for Internal Combustion Engine Work, about 30 miles from London. Applicants should state age, experience and salary required. No person already employed on Government work will be engaged.—Apply at your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 261.

Wanted, One or Two Mechanical DRAUGHTSMEN, with a fair knowledge of foundry work. No one already engaged on Government work or resident more than 10 miles away need apply.—Address, O 264, Offices of ENGINEERING.

Draughtsmen Required for Controlled Aircraft Establishment in N.W. district, with knowledge of Jigs and Press Tools preferred. Shop experience essential. No one engaged on Government work or living more than 10 miles away need apply.—Write, BOX 37, SELLS Ltd., 168, Fleet Street, E.C. 4. O 267

Draughtsmen. — Wanted Immediately, General Assistant Draughtsmen, experienced in design of steam engines, boilers and steam plant lay-outs preferred. State full particulars of age, experience and salary required. No person already engaged on Government work will be engaged.—Apply, nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 272.

First-class Draughtsman ReQUIRED, experienced in Drop-valve Engines and Condensing Plants. No one employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 275.

Draughtsman Required. One with Machine Tool experience preferred. Good post war prospects. State age, experience and salary. No one employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 277.

Draughtsmen Wanted. High-class firm of Automobile Manufacturers have vacancies for Senior and Junior Draughtsmen with experience in Engine and Chassis design. State qualifications, age, experience and salary required. No person already employed on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning No. A 6273. O 263

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Wanted for London Office— ENGINEERS' DRAUGHTSMAN, experienced in Steam Generation Plant & Boiler House equipment. No person resident more than 10 miles away or already employed on Government work will be engaged.—Address, O 293, Offices of ENGINEERING. O 293

Draughtsmen Wanted for urgent Government work by crane makers in Manchester district. Applications invited from good mechanical and structural men. Crane experience not essential. State age, salary and experience. No one on Government work will be engaged. —Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 148.

Tool and Plant Draughtsmen REQUIRED for urgent Aero and Motor work in progressive Midland works. Permanencies for five, interested, quick men with initiative and ability. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. 5316. M 610

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Also a good JUNIOR DRAUGHTSMAN.
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Apply in first instance to nearest EMPLOYMENT EXCHANGE, quoting No. 5358, and giving full particulars. M 404

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Draughtsman Required, for large Ironworks and Collieries in the Midlands. Permanent appointment for suitable man. No person already on Government work will be engaged. In reply, state age, previous experience and salary expected.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 242.

Wanted, Experienced DRAUGHTSMAN, for large Engineering Works, Manchester district, used to general maintenance work, lay out of plant, buildings, &c., also general repair of machines. No one already on Government work will be engaged. State age, experience and salary required.—Apply, your nearest EMPLOYMENT EXCHANGE, quoting No. A 5826. M 967

Draughtsman, Mechanical. Used to machine tool attachments and able to check drawings. Must be accurate and quick in getting work out when required urgently. No one resident more than 10 miles away or at present employed on Government work need apply. State age, experience and salary required, enclosing copies of any recent testimonials.—Address, O 235, Offices of ENGINEERING.

Ship Draughtsman, Experienced, REQUIRED for Reinforced Concrete Shipbuilding. No person at present engaged on Government work need apply.—Apply, with full particulars, to your nearest EMPLOYMENT EXCHANGE, quoting O 229 and this Journal.

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EXACT DATA ON THE RUNNING OF STEAM BOILER PLANTS No. 1.

By D. Brownlie, B.Sc.Hons.(Lond.), F.C.S. J. Compston, and H. W. Royse.

We suppose that it is common knowledge among scientific engineers that the general methods in use of running boiler plants are not efficient. Very little information has, however, been published as to the actual figures being obtained in practice, and the saving to be effected by the adoption of more up-to-date and scientific methods. There is little or no reference to this very important section of engineering knowledge, either in text books, reference books, or general engineering literature. Much of the scanty information available is contained in the catalogues of various engineering firms, and whilst this information is naturally somewhat prejudiced most engineers are apt to regard it as even worse in this respect than it really is.

We shall endeavour to reduce this gap in our general engineering knowledge by presenting a series of articles on different sections of this important subject. These articles will contain data based on ten years continuous experience in investigating and reorganising steam boiler plants in all parts of Great Britain, and will treat in more complete detail the figures for the performance of 250 typical steam boiler plants in 27 different industries already given in Engineering ("Coal Saving by the Scientific Control of Steam Boiler Plants," D. Brownlie, July 12 and 19, 1918).

1. Economisers.

The economiser was introduced about seventy years ago, and is so well known to all steam users, either by practical experience or by repute, that only a brief description is necessary. It consists essentially of a series of vertical cast-iron tubes placed in the hot exit gases from the boilers and so arranged that the boiler-feed water passes through the tubes on its way to the boilers, thus absorbing a large proportion of the heat in the gases which would otherwise be wasted.

The tubes are provided with automatic scrapers to keep the outside surface free from soot and dirt to allow the conduction of the heat from the hot gases through the tubes to the water passing along inside. The present standard design of economiser has been practically the same since the first inception and, like the "Lancashire" boiler, it would seem to be a very difficult matter to suggest any real improvement on the original design.

The economiser pipe is usually of a standard dimension of 9 ft. length and $4\frac{5}{16}$ in. external diameter, being constructed to suit the boiler pressure and tested by hydraulic pressure to, say, 200 lb. over working pressure. Each of these standard pipes has approximately 10 sq. ft. of heating surface, holds $6\frac{1}{2}$ gallons of water and weighs $\frac{1}{4}$ ton. The power required to drive the scrapers is very small, being, for example, about $\frac{1}{4}$ h.p. for a set of 96 tubes. Cast-iron is the most suitable material for the tubes, at any rate up to 300 lb. steam pressure, as steel, wrought iron, copper, brass, &c., will not resist so well the corrosive action of the hot gases.

As regards the number of economisers installed it is impossible to say as we have no proper engineering census, but probably something like 400,000 to 500,000 boilers have been equipped in the world, corresponding to, say, 60,000,000 h.p. to 70,000,000 h.p.

The number of tubes to be installed on any given boiler plant is usually reckoned in a very crude manner and characteristic of our usual lack of scientific methods in industry. The makers recommend an installation large enough to hold one hour's supply of feed water in the pipes. Thus if a boiler is evaporating 650 gallons per hour, each tube holds $6\frac{1}{2}$ gallons, and the number of economiser tubes would be then 104. Because of the gearing arrangement economisers can only be made in certain standard sections of 6, 8 or 10 tubes wide, the wider sections being used for larger boiler plants A plant of one boiler only would have a standard 6-tube wide economiser and the nearest standard size to 104 tubes would be 96, being 6 tubes wide in two sections of 8 tubes in length. The next size of grouping would be 120 tubes, in 20 sections 6 tubes wide. Larger sets of economisers would be 8 tubes wide or 10 tubes wide to diminish the resistance to the draught. As we have already pointed out ("Coal Saving by the Scientific Control of Steam Boiler Plants," Engineering, July 12 and 19, 1918) not 5 per cent. of the boiler plants of the country are fitted with apparatus for determining accurately the evaporation, so that it is obvious the installation of economisers is in practice to a large extent a matter of guesswork. When the evaporation is not known it is customary for example, to allow 4 pipes for every ton of coal burnt per week of 54 hours, or one pipe for every 3 i.h.p. developed.

When it is remembered that coal may contain anything from 9,000 British thermal units to 14,000 British thermal units of heat per pound, that an engine may take from, say, 12 lb. to 35 lb. of steam per indicated horse-power and a standard 30 ft. by 8 ft. "Lancashire" boiler may be evaporating anything from 300 gallons to 1,000 gallons per hour, it will be obvious that with these methods the economiser does not get a fair chance to show maximum efficiency.

The chief advantage and the main point of interest in connection with economisers is, of course, the saving in the coal bill to be obtained by their installation. There are very few data given on this subject in general reference books and text books on engineering, except the stereotyped figures of 15 per cent. to 25 per cent. saving taken from makers' catalogues.

As already pointed out we have made a complete scientific investigation of the working of 250 typical steam boiler plants in the British Isles in 27 different industries, and we claim that these plants are typical of all the boiler plants of the country. These plants comprise exactly 1,000 boilers, consisting of 935 "Lancashire" boilers, 36 modern "tubular" boilers, 17 "egg-ended" boilers, 6 "Cornish" boilers, 1 "marine" boiler, 2 "vertical" boilers, and 3 "patent" boilers, burning a total of 2,166,000 tons of fuel per annum. The figures obtained show that out of the 250 plants only 155 plants were fitted with economisers, the other 95 plants having no means of utilising the waste heat from the boiler flues. Taking now these 155 plants, the exact average saving obtained was 11·4 per cent. of the coal bill. We give these results in further detail in the Table I. below, dividing the plants into six divisions according to the saving obtained.

In actual practice, therefore, only about 17 per cent. of the plants fitted with economisers were saving 15 per cent. or over of the coal bill, whilst over 30 per cent. were saving less than 10 per cent., the true average for the whole 155 plants being 11·4 per cent., as stated above.

The beneficial rise in temperature of the feed-water for each of the six divisions can be seen from the table, whilst the average figures from the 155 plants added together are 115 deg. F. before the economisers and 241 deg. F. after, an average rise of 126 deg. F., equivalent to 11·4 per cent. saving. The corresponding fall in the flue gas temperatures can be seen from the table, whilst the exact figures from the 155 plants are 581 deg. F. before the economisers and 389 deg. F. after.

The reason the average figures for the actual

TABLE I.—Showing Results of Working with Economisers.

Division According to Saving Obtained.	No. of Plants.	Average Temperature of Feed-water.		Average Temperature of Flue Gases.		Draught in Inches. W.G.		Steam Press Gauge.	Total Evaporation on Plant per Hour.	No. of Tubes on Plant.
		Before.	After.	Before.	After.	Chimney Base.	Side Flue or Downtake of Boilers.			
		deg. F.	deg. F.	deg. F.	deg. F.	—	—	lbs. per sq. in.	lb.	—
No economiser at all.. ..	95	—	—	—	—	—	—	—	—	—
Less than 5 per cent. ..	14	134	172	568	371	0·85	0·41	80·0	17,616·0	226
5 per cent. to 7½ per cent. ..	15	123	194	576	423	0·61	0·35	79·0	15,340·0	208
7½ per cent. to 10 per cent..	23	119	261	549	374	0·74	0·33	100·0	16 630·0	231
10 per cent. to 12½ per cent..	33	118	243	583	403	0·88	0·39	106·0	23,723·0	401
12½ per cent. to 15 per cent.	46	110	262	584	379	0·99	0. 41	99·0	19,760·0	280
Over 15 per cent.	24	170	284	610	375	1·35	0·60	119·0	23,497·0	392
Total plants	250									

TABLE II.—Detailed Results of Working of Economisers in 24 Plants Saving over 15 Per Cent.

No. of Plant.	Average Temperature of Feed Water.		Average Temperature of Flue Gases.		Draught in Inches.		Steam Pressure Gauge.	Total Evaporation on Plant per Hour.	Number of Tubes in Economiser on Plant.	Per Cent. Saving due to Economisers.
	Before Economisers.	After Economisers.	Before Economisers.	After Economisers.	W.G. Chimney Base.	Side Flues or Downtake Boilers.				
	deg. F.	deg. F.	deg. F.	deg. F.			lb per sq. in.	lb.		per cent.
1	100	321	512	344	1·40	0·50	180·0	18843·0	480	19·6
2	59	282	548	328	1·52	0·98	81·0	41166·0	560	19·3
3	95	311	680	375	3·10	0·80	161·0	37785·0	488	19·2
4	65	281	605	475	1·50	0·80	76·0	18174·0	288	18·8
5	88	289	662	372	0·67	0·28	97·0	12882·0	394	17·8
6	80	266	625	420	0·45	0·85	79·0	16395·0	216	17·8
7	112	309	565	393	0·45	0·75	98·0	5310·0	120	17·8
8	90	301	609	366	1·70	0·82	139·0	72516·0	960	17·6
9	115	303	585	324	1·00	0·60	119·0	14394·0	192	17·4
10	110	308	689	448	1·20	0·86	104·0	11578·0	320	17·4
11	104	296	616	377	0·60	0·40	74·0	6032·0	144	17·3
12	92	289	612	336	1·70	0·66	180·0	16118·0	256	17·3
13	151	333	463	370	0·61	0·42	160·0	11830·0	320	16·9
14	91	275	609	377	1·00	0·59	95·0	7968·0	192	16·9
15	105	287	759	525	1·20	0·60	103·0	29484·0	640	16·3
16	133	307	715	353	1·75	0·45	120·0	41435·0	640	16·0
17	79	259	609	450	0·92	0·55	111·0	12908·0	320	15·8
18	129	302	487	325	1·68	0·52	154·0	6390·0	160	15·7
19	114	286	603	387	1·50	0·60	112·0	24808·0	384	15·6
20	100	280	749	550	1·50	0·70	103·0	8734·0	96	15·4
21	107	276	597	328	1·15	0·30	81·0	25264·0	400	15·3
22	115	281	539	463	0·90	0·30	72·0	7676·0	168	15·2
23	117	284	588	394	1·15	0·55	85·0	18219·0	280	15·2
24	88	260	599	321	1·24	0·35	157·0	98032·0	1408	15·1

saving are only 11·4 per cent. is not, of course, the fault of the economiser as an appliance, but is due to the fact that the economical generation of steam on scientific lines is not understood, and economisers generally are not installed on correct lines. The economiser is, of course, an absolutely essential part of any up-to-date boiler plant, and the saving obtained should be 17½ per cent. to 20 per cent. under average conditions. In this connection the figures of each of the separate 24 plants found to be saving 15 per cent. or over, given in Table II, will be of interest, showing what is actually being done on many boiler plants.

The other advantages of the economiser are the reduction of the strain on the boilers by the provision of a high-temperature feed water preventing unequal expansion and contraction, and also that there is always a large reserve of hot water at hand

for any sudden demand for steam. Further, the evaporative capacity of the boilers is greatly increased.

It is also necessary to consider the disadvantages of the economiser. First, we have a very serious choking of the draught caused by the cooling of the gases. Taking natural draught first, the draught in a chimney is, other things being equal, simply dependent on the mean temperature of the gases in the chimney, the draught being caused by the difference of the density of the hot gases in the chimney and the cold air outside. Thus, for example, taking a brick chimney 170 ft. high with a temperature in the base of 600 deg. F. The temperature of the gases in the chimney is reduced about 2 deg. F. for every 3 ft. in height by the cooling action of the air, so that the mean temperature of the hot gases in the chimney will be about 544 deg. F., taking the temperature of the air as 60 deg. F. The actual draught in inches water gauge at the chimney base is given very nearly by the following formulæ (which allows for friction losses) :—

$$P = H\left(\frac{7{\cdot}6}{t} - \frac{7{\cdot}9}{T}\right)$$

where P = inches water gauge.
H = height of chimney in feet above firing level.
T = mean absolute temperature of chimney gases.
t = absolute temperature of atmosphere.

$$P = 170 \times \left(\frac{7{\cdot}6}{60 + 461} - \frac{7{\cdot}9}{544 + 461}\right)$$
$$= 170 \times \left(\frac{7{\cdot}6}{521} - \frac{7{\cdot}9}{1{,}005}\right)$$
$$= 170 \times (0{\cdot}01458 - 0{\cdot}00786)$$
$$= 170 \times (0{\cdot}00672)$$
$$= 1{\cdot}14 \text{ in. W.G. corresponding to, say, } 0{\cdot}60 \text{ in. W.G. in the side flues of a "Lancashire" boiler.}$$

If now we install economisers and reduce the coal bill, say, 17½ per cent., the temperature of the gases will be reduced from 600 deg. F. to, say, 350 deg. F. The mean temperature in the chimney will now be only about 294 deg. F., and the draught will be :—

$$P = H\left(\frac{7{\cdot}6}{t} - \frac{7{\cdot}9}{T}\right)$$
$$= 170\left(\frac{7{\cdot}6}{60 + 461} - \frac{7{\cdot}9}{294 + 461}\right)$$
$$= 170\left(\frac{7{\cdot}6}{521} - \frac{7{\cdot}9}{755}\right)$$
$$= 170\,(0{\cdot}01458 - 0{\cdot}01046)$$
$$= 0{\cdot}70 \text{ inches W.G. corresponding to, say, } 0{\cdot}35 \text{ inches W.G. in the side flues of a "Lancashire" boiler.}$$

As a rule we did not take the draught actually before and after the economiser, but in the chimney base (or fan inlet) and the side flues or downtake of the boilers (or analogous position). As already seen, the figures for the whole 155 plants show a drop in the temperature of the flue gases from 581 deg. F. to 389 deg. F., whilst the draught averages about 0·97 in W.G. at the chimney base and 0·45 in. W.G. in the side flue or downtake. It is, of course, difficult to say what would be the results if the economisers had not been installed, but at 581 deg. F. in the chimney base on a rough average of the 155 chimneys, the figures for the draught would have been about 1·10 in. W.G. at the chimney base and 0·60 in. W.G. in the side flues or downtake. There is obviously therefore a very serious drop in the draught, which causes great difficulties.

For example, on theoretical grounds, if more economisers were installed and the saving brought up to, say, 22½ per cent., and the gases cooled to, say, 250 deg. F., the draught would be so seriously diminished that hardly any coal at all would be burnt. The reason is that the chimney, as a draught producer, is a thoroughly unscientific and wasteful method of creating a draught, simply depending for its efficiency on a shocking waste of heat. If now this waste is utilised to the full by the economiser then the draught is curtailed and it is impossible to burn the necessary amount of coal to maintain the evaporation, in spite of the assistance of the economiser. There are hundreds of boiler plants in the country that are forced, for this reason, to open slightly the bye-pass dampers and allow a portion of the hot gases to go straight up the chimney to waste so as to maintain a draught to burn the amount of coal required to keep up steam. The mere installing of economisers on rule-of-thumb lines may therefore in some cases be of little real advantage. This difficulty is, however, of little or no importance in the case of mechanical draught.

Another disadvantage of the economiser is encrustation, the formation on the inside of the tubes of a hard deposit of scale from impurities in the feed water which prevents the conduction of the heat from the hot gases, and is very liable to cause the tubes to be burnt out.

The hardness of the water used on the 155 plants was remarkably uniform, averaging 8 per cent. to 9 per cent. total hardness. The worst case was 26 deg. total hardness, with two of 23 deg., whilst 16 cases were 15 deg. or over.

The obvious remedy is, of course, to soften the water and deliver it into the economisers not over, say, 5 deg. to 6 deg. hardness, when all encrustation troubles are at an end. Many firms have to bore out the scale in the tubes regularly, a laborious and expensive operation. Some cases of encrustation are extraordinary, most of the tubes in the economiser being absolutely solid with scale in twelve months.

A further source of trouble of the economiser is corrosion of the pipes. This is caused by the condensation of the acid flue gases on the outside of the tubes at the lower end where the cold water enters. Flue gases contain sulphurous acid from the sulphur in the coal, which condenses because of the great difference in temperature between, say, 600 deg. of the gases and 50 deg. F. of the inlet water. This corrosive action is intensified by excessive sulphur in the coal and moisture in the flue gases due to damp flues or by excessive amount of steam being used for steam-jet furnaces.

Thousands of economiser pipes have been rendered useless in a few years because of this action. One remedy is to ensure that the feed water does not enter the economiser at a temperature of less than 100 deg. F., by providing an automatic circulating arrangement to take continuously a small portion of the water from the hot end and mix it with water from the cold end. Another minor disadvantage is the cost and trouble of attendance in the way of power, oil, extra cleaning of flues, &c.

There are a number of firms who supply economisers, and the prices vary somewhat, but the cost of an economiser installation is approximately as follows :—

Taking for example a standard set of 192 tubes, eight tubes wide, the economiser complete will cost to-day, say, 576*l.*, or about 3*l.* per tube. The engine for driving the scrapers, capable of developing about 2 h.p., will cost, say, 55*l.*, whilst the inlet and outlet dampers for the economiser flues (7 ft. by 3 ft.) will cost a total of, say, 25*l.* for the two dampers.

The total cost of the erection, brickwork, foundations, and labour from inlet to outlet damper, will be very approximately 200*l.*, so that the total cost of the whole installation is, say, 950*l.*, allowing 100*l.* for extras. If now the installation has been designed on correct lines for the particular circumstances of the plant, and the inherent disadvantages of the economiser obviated, then the saving will be, say, 17½ per cent., and the life of the whole installation twenty years.

Taking the coal bill for a boiler plant for which 192 tubes are suitable, say, two "Lancashire" boilers burning 2,000 tons of coal per annum at 20*s.* per ton, equals 2,000*l.* per annum, 17½ per cent. saving is 350*l.* per annum. In twenty years this will be 7,000*l.*, and allowing, say, 500*l.* for cost of attendance, minor repairs, oil, and power, during the whole of the time, this will leave a net saving of 6,500*l.*, which is a handsome investment on the capital expended. On a large installation the figures are much more favourable. Thus, taking a plant of ten boilers (evaporation 6,000 gallons per hour) with a coal bill of 10,000*l.* per annum, 17½ per cent. saving equals 1,750*l.* per annum, that is 35,000*l.* in twenty years. An installation of 960 tubes would cost to-day, approximately, inclusive of engine, dampers, foundations, brickwork and labour, about 4,500*l.*, and 1,500*l.* would cover cost of attendance and up-keep.

It should be clearly emphasised, however, that these favourable figures will only apply to a plant designed and worked on scientific lines. As already seen the average saving obtained in practice is only about 11 per cent., whilst the average life of all the economisers in the country is certainly not twenty years. Many thousands of tubes only last five years, and a life of ten or twelve years is comparatively common.

As already pointed out in the original article, the total amount of coal burned per annum in steam boilers for the generation of steam in the whole country is probably 75,000,000 tons to 100,000,000 tons. On the 250 plants, the average saving due to economisers was only 7·1 per cent., including 95 plants not fitted with economisers. This figure can be assumed to be correct for the whole of the country, at any rate until further information is available.

As already seen, an economiser plant working on efficient lines will save, say, 17½ per cent. of the coal bill in average cases, so that if all the boiler plants in the country are made up-to-date in this respect and the saving increased from 7·1 per cent. to 17·5 per cent., the net saving would be 10·4 per cent. This would correspond to no less than, say, 7,000,000 tons to 10,000,000 tons of coal per annum, assuming that the economisers were installed on correct scientific lines.

TWO *VERSUS* FOUR-CYCLE INTERNAL-COMBUSTION MARINE ENGINES.

By Giovanni Chiesa, Manager of Messrs. Ansaldo San Giorgio's Works at Turin.

The relative superiority of two or four-cycle internal combustion engines for marine purposes is one of the most debated questions at the present moment from a theoretical as well as from a practical standpoint : thus it forms daily the subject of discussions, lectures and articles in technical reviews. The chief purpose of this article is to co-ordinate the arguments which have been alleged for and against both types in their best form of construction, and to endeavour to draw a conclusion after careful consideration of all points of the question.

The advantages which are usually attributed to the two-cycle engine as compared with the four-cycle type may be briefly stated as follow :—

(A) The two-cycle engine develops a greater power than the four-cycle with the same number and size of the cylinders and the same number of revolutions. This advantage of the two-cycle type is due to the fact that the four-cycle type gives an impulse for each cylinder every two revolutions, whilst the two-cycle type gives an impulse each revolution ; theoretically the two-cycle type should therefore develop, under the same conditions, a power double that of the four-cycle type. In practice, however, the said theoretical limit has never been reached, but at present it may be said that the power developed by a two-cycle engine is 175 per cent. to 190 per cent. of that of a four-cycle engine, and it may be added that whilst the mean effective pressure in the four-cycle type is about 5 kg. per cm.² (71 lb. per sq. inch) that of the two-cycle type is practically of 4·4 kg. to 4·75 kg. per cm.² (62 to 67 lb. per sq. inch).

This essential advantage of the two-cycle type brings as a consequence a remarkable reduction of space and weight, which may be approximately calculated in the following manner : As there is no reason that a four-cycle cylinder with its framing and driving gear (assuming the same intensity of stress of the materials) should weigh less than a two-cycle cylinder of the same size, and as the weight can be practically considered to be proportional to the volume swept by the piston, therefore, for the same power and number of revolutions, the cylinder of the two-cycle engine (175 per cent. being taken as the power-ratio of the two-cycle to the four-cycle type) has a weight which is 57 per cent. of that of the four-cycle engine.

This advantage is somewhat reduced by the fact

that the two-cycle engine needs scavenging pumps, and as, according to circumstances and to the different design of the pumps, their weight can be considered as being 8 per cent. to 12 per cent. of the weight of the cylinders, it results that the weight of the two-cycle type will be 62 per cent. to 65 per cent. as compared with the weight of the four-cycle. The above figures seem also practically confirmed, though there is always some difficulty in comparing numbers quoted by different constructors, for they do not always state which parts of the equipment of the plant are included or excluded from the figures published. But besides the saving of weight there is also the saving of space, and on this particular point it is preferable to refer the reader to the diagrams, Figs. 1, 2, 3 and 4, on the present page and pages 484 and 485, which show the two-cycle engines of the ship Ceara constructed by the firm of Fiat San Giorgio (now Ansaldo San Giorgio), as compared with four-cycle engines of the two best-known types: Burmeister and Wain, and Werkspoor.

It must be noted that the saving in space by the two-cycle type has also as a consequence a considerable saving in the cost and weight of the engine seat as well as in the dimensions of the engine-room, facilitating the supervision and control of the machines.

(B) The turning-moment in the two-cycle engine is far more regular (for the same number of cylinders) than in the four-cycle type; Fig. 5, on page 485, compares the diagrams of the turning moments of a four-cycle six-cylinder engine with that of a two-cycle six and four-cylinder type, illustrating the great difference in the regularity of the two types; the results of even the four-cylinder two-cycle type are far more regular than those of the six-cylinder four-cycle engine.

This advantage of the two-cycle engine is not merely theoretical, but in practice results in a minor intensity of the vibrations of the stern end of the ship, besides a reduction in size and weight of the line of shafting and consequently of its fittings, such as supports, stern tube, etc. According to the rules of Lloyd's Register, the section of the shafting of a six-cylinder four-cycle engine (for the same power and the same number of revolutions) ought to be 45 per cent. greater than that of the six-cylinder two-cycle engine, and 11 per cent. greater than that of the four-cylinder two-cycle engine.

Furthermore, the reduced size of the flywheel in the two-cycle engine and the reduced space permits of placing the engine nearer the stern, not only saving in the length of the line of shafting but also increasing the space available on board for the cargo.

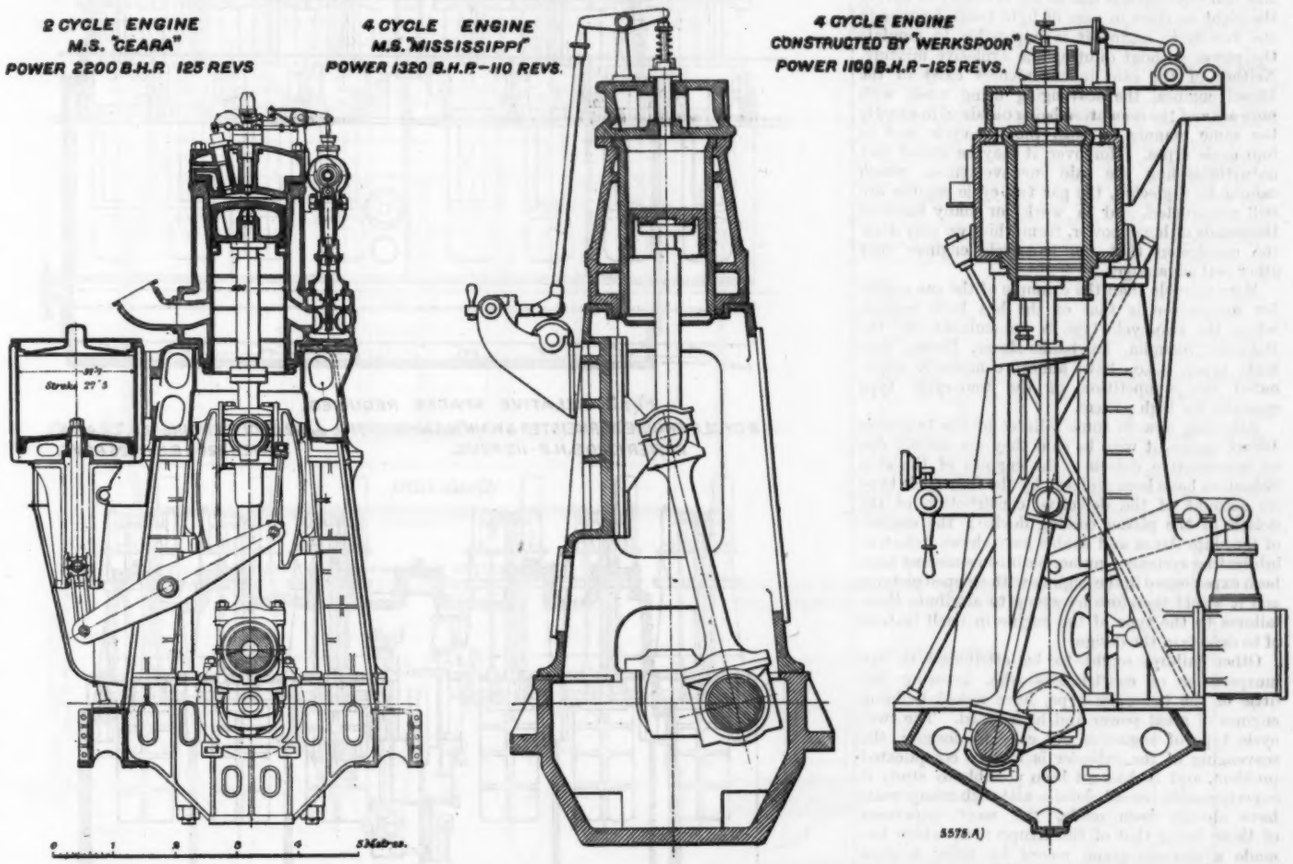
(C) The two-cycle engine offers greater facility in reversing as compared to the four-cycle type, which is due to the fact that in the former the exhaust of the burnt gases takes place through ports in the cylinder wall, so that in order to reverse the running it is only necessary to alter the timing of the scavenging valves, of the fuel valve and of the starting valves. This alteration in the timing of the scavenging valves is very readily made by simply rotating the camshaft relatively to the crankshaft, whilst the alteration in the timing of the fuel and starting valves (these valves having but a small lift) can be readily effected by employing double cams sliding on the shaft.

In the four-cycle type on the contrary, besides the alteration in the timing of the fuel and starting valves, it is necessary separately to reverse the inlet and exhaust valves; and as the latter operation requires a different rotation of the camshaft, it is not possible to employ the simple device of the two-cycle type, but much more complicated mechanisms become necessary.

Referring, further, to the starting and reversing devices, it may be added that the necessity of being able to start the engine whatever be the position in which the crankshaft has stopped, that is to have at least one of the cylinders in the inlet phase of the starting air, does not permit of a reduction in the number of the cylinders to less than six in the four-cycle type, whilst the two-cycle can be constructed with but four and keep its perfect manœuvreability.

(D) With the two-cycle engine the inertia of the reciprocating parts, such as connecting rods, pistons, &c., is balanced at top dead centre by the pressure on the piston, which cannot be realised in the four-cycle for the exhaust and suction strokes. As a consequence, in the four-cycle engine the piston rods are subjected to alternative compressive and tensile stresses, so that the caps and bolts of the connecting-rod heads and of the main bearings must be necessarily constructed much more strongly than in the two-cycle type in order to avoid the possibility of their breaking and the great damage which this would cause.

Fig. 1. RELATIVE SPACES REQUIRED FOR VARIOUS TYPES.



(E) The two-cycle engine does not require any exhaust valve for the burnt gases, and in the engine provided with port scavenging there is no need of any valve subjected to the action of the burning gases; in the four-cycle type the exhaust valves are the source of well-known troubles and even in the case where their tightness and durability is increased by using more or less complicated cooling devices, the danger of their falling into the cylinder, with all its serious consequences, can never be fully eliminated.

It should be noted that the exhaust valves in the four-cycle engine are the parts which are most sensitive to the quality of fuel and are especially liable to suffer by the asphaltum and sulphur sometimes present in heavy oils of certain origins. For a two-cycle engine without exhaust valves there may consequently be used certain kinds of fuel which are not suitable for a four-cycle engine.

Against the advantages above referred to as to the two-cycle type, the advocates of the four-cycle engine oppose some objections which partially apply to all two-cycle engines, and partially only to special types or to constructive details of them. These objections may be briefly stated as follow:—

(*a*) In favour of the four-cycle type it has been said that the experience of the gas engine has led back again (after a period of preference for the two-cycle type) to the four-cycle engine; also several failures are imputed to the Diesel two-cycle engine, so that it is convenient to select again the four-cycle type.

Against this objection we may note that the example of the gas engine is not directly applicable; the two-cycle gas engine, as compared with the four-cycle, shows the disadvantage of a greater consumption and of an inefficient regulation at light loads; the greater consumption being due to the fact that a certain amount of gas is always mixed with the scavenging air because the two fluids cannot remain wholly separated, and so unburnt gas escapes with the air through the exhaust ports without producing any useful work. The bad regulation is due to the difficulty of having the right mixture in case of light loads, because in the two-cycle engine it is impossible to regulate the power without diluting the explosive mixture. Neither of the said inconveniences exist in the Diesel engines, the scavenging being made with pure air and the regulation being obtained in exactly the same manner in both the two-cycle and in four-cycle types. Moreover, it may be stated that notwithstanding the said inconveniences, which cannot be neglected, the gas two-cycle engines are still constructed, and in work for many hundred thousands of horse-power, from which we may draw the conclusion that the two-cycle engines offer other real advantages.

More suitable than the example of the gas engine for comparison is that of the hot bulb engines where the two-cycle type is pre-eminent, for the Bolinder, Skandia, Fairbanks-Morse, Petter, Torbinia types, a.s.o., have almost completely eliminated the competition of the four-cycle type specially for high powers.

Referring now to some failures of the two-cycle Diesel engine, it may be said they are mainly due to constructive defects; the engines of the ship Sebastian have been replaced by the four-cycle type on account of the defective construction of the details of the piston cooling device; the engines of the ships Arum and Arabis have shown defective lubricating systems; numerous inconveniences have been experienced in the engines with stepped pistons, and it would therefore be wrong to attribute these failures to the type of the engine in itself instead of to defects in the design.

Other failures ought to be attributed to the inexperience of constructors who, knowing but little of the two-cycle type, have risked building engines of great power and high speed. The two-cycle type of engine is not easy to design; the scavenging of the cylinder is a very complicated problem, and it has not been possible to study it experimentally in all details although many trials have already been made, the most important of these being that of the Krupp firm, which has made a cinematograph record by using a glass cylinder. For scavenging it is necessary that the air current in the cylinder should fully and readily displace the combustion residues without mixing with them. The study and design of a convenient system of ports passages, as well as of suitable scavenging organs, in order to obtain a perfect scavenging, and at the same time the most reduced power-consumption for driving air pumps, is a problem which can only be solved completely by many trials and long and costly experiments.

Should the cylinder and the scavenging ports not be well designed, and the scavenging be imperfect, the working of the engine will be bad; instead of having the cylinder filled with pure air for the combustion, there will be therein a mixture of the air with the burnt gas not fully exhausted, so that the combustion will take place irregularly and be delayed, the fuel being therefore inefficiently utilised and at the exhaust such temperatures may be reached as may greatly reduce the durability of the cylinders and of the engine itself.

The two-cycle engines which are constructed at present by experienced manufacturers, and especially those with port scavenging, are by no means less reliable than the four-cycle type. For obvious reasons it is not possible to speak of engines installed on warships (the brilliant trip of a small Russian submarine from Spezia to Arkangel cannot be forgotten), but the success of the Monte Penedo and of the Ceara, which latter is the most powerful ship in service at present, are undeniable proofs that the two-cycle engine, if well constructed, can give the best results.

Considering the extensive use made in the German navy of combustion engines of both the four-cycle and the two-cycle types, it is noteworthy that the important company, Hamburger Werft A.G., recently founded by the A.E.G., and by the Hamburg-America Linie, for the construction of motor-ships, under the management of the well-known Ballin, will give the preference to the two-cycle engine.

Fig. 2. RELATIVE SPACES REQUIRED.

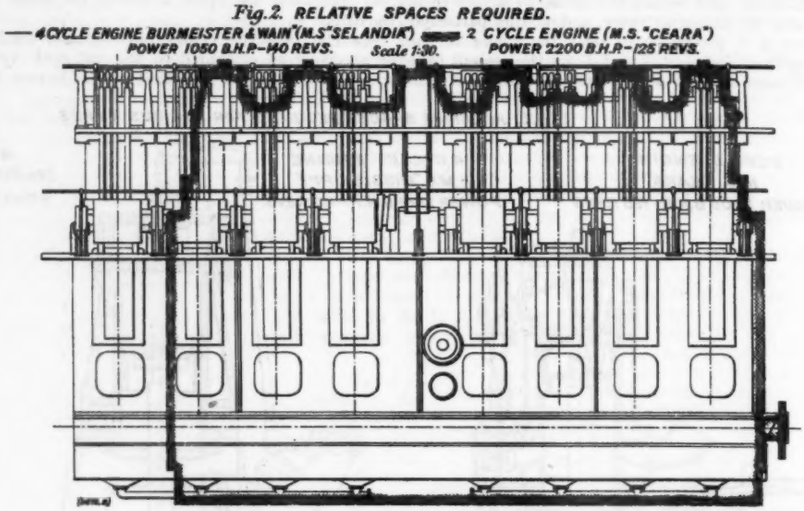
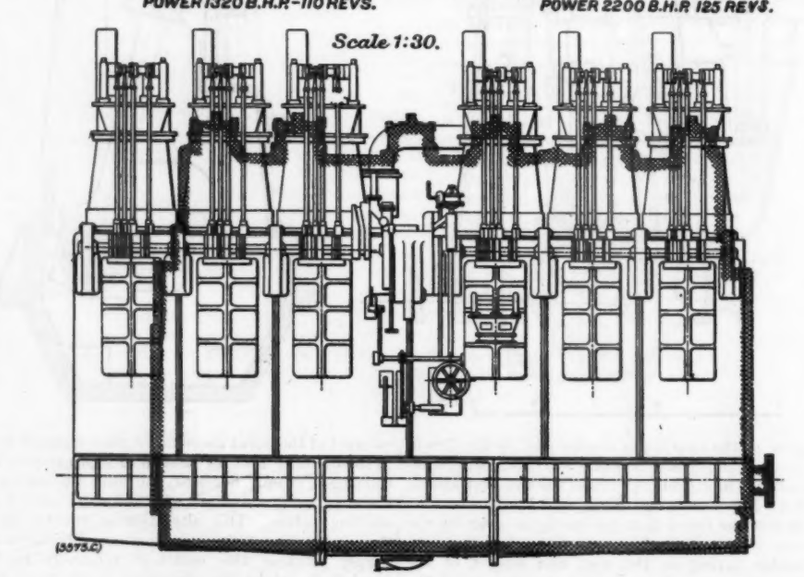

4 CYCLE ENGINE BURMEISTER & WAIN (M.S. "SELANDIA")
POWER 1050 B.H.P.–140 REVS.
Scale 1:30.
2 CYCLE ENGINE (M.S. "CEARA")
POWER 2200 B.H.P.–125 REVS.

Fig. 3. RELATIVE SPACES REQUIRED.


4 CYCLE ENGINE BURMEISTER & WAIN (M.S. MISSISSIPPI).
POWER 1320 B.H.P.–110 REVS.
2 CYCLE ENGINE (M.S. "CEARA").
POWER 2200 B.H.P. 125 REVS.
Scale 1:30.

(*b*) The supporters of the four-cycle type allege that the two-cycle engines are far more complicated, not only on account of the scavenging pumps, the piping and the receivers relating thereto, but also on account of the greater complexity of the valve gear.

Against this assertion it may be objected that the air pumps which undoubtedly constitute an added organ, by no means interfere with the reliability of the working of the engine, as they are always working at very low pressures and temperatures like the low-pressure cylinders of steam engines; and constructively it is certainly more rational to employ a suitable air pump instead of using, for half the time, for displacing the air, enormous pistons which have been designed and fitted with rings for at least a hundred times higher pressure.

Referring now to the valve gear, the complexity pertains exclusively to that two-cycle type of engine having scavenging valves in the cylinder-heads, whilst in the recent type with port scavenging, besides the fuel and the starting valve (like that of the four-cycle type), there is only the scavenging valve to control. This is light and easily displaced, as it is not subjected to the highest pressures and temperatures of the cycle, and it does not require to be perfectly tight. This valve can easily be replaced by a rotary valve. In the cylinder of the four-cycle engine, instead of one scavenging valve there are two at least to be controlled, and very often two inlet and two exhaust valves, which, being placed in the combustion chamber, require to be perfectly tight and need a precise and reliable operating gear in order to withstand the effort of the powerful closing springs.

(*c*) In favour of the four-cycle type it has been furthermore affirmed that its fuel consumption is far lower than that of the two-cycle engine. Now even if it must be admitted that this objection is correct in relation to the first two-cycle

engines which were constructed, and is also applicable to some present motors of defective construction, it has, nevertheless, lost much of its importance when comparing the four-cycle engine with the best-known modern two-cycle engines.

For slow two-cycle engines the consumption may be reduced under 200 grammes (0.344 lb.) per b.h.p. per hour. The consumption of 194 grammes per brake horse-power has been obtained since 1915 with the 2,200 brake horse-power two-cycle engines of the ship Ceara on a brake test, with the most careful observation and all auxiliary pumps (such as scavenging, compressing and water, or oil pumps) directly driven, working with heavy oil of a poor quality of the density of 0·90. For the high-speed (0·401 lb. to 0·414 lb.) per brake horse-power, often excluding the consumption of the auxiliary pumps which were separately driven. With the high-speed type the competition of 1913 of the German Admiralty for electric sets developing 300 kw. at 400 revolutions, in which the most important manufacturers specialising in the construction of the Diesel engines took part (for instance, M.A.N., Krupp, Koerting) has led to figures, which were officially published in *Der Oelmotor*, 1913, and according to which the consumption in the four-cycle engines was from 197 grammes to 203 grammes (0·434 lb. to 0·447 lb.) per b.h.p. per hour.

It is true that some excessively low figures have been singly reported for the consumption of four-

Fig. 4. RELATIVE SPACES REQUIRED.

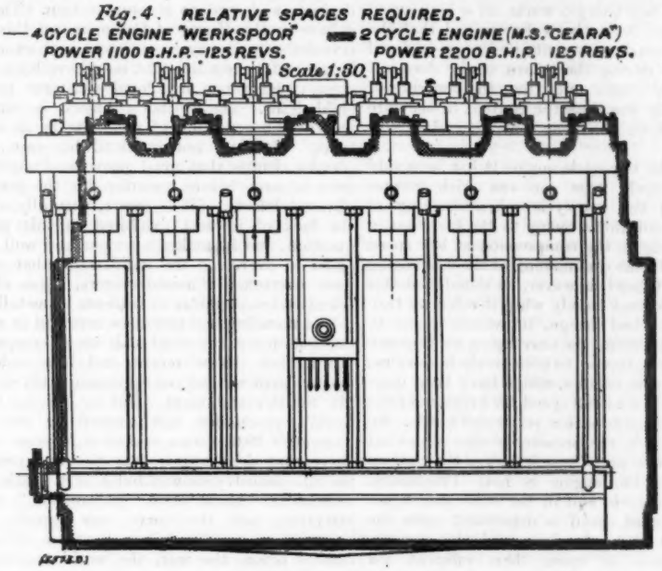


Fig. 5. DIAGRAM COMPARING THE TURNING MOMENTS OF TWO-CYCLE AND FOUR-CYCLE ENGINES.

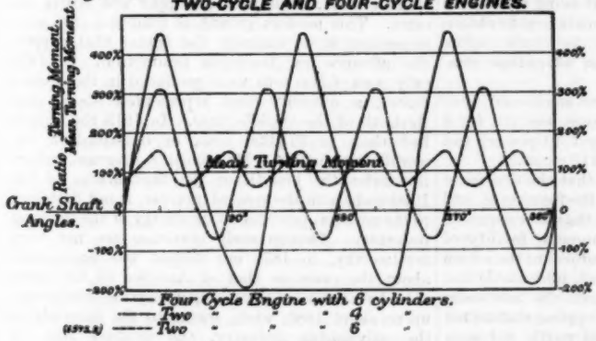
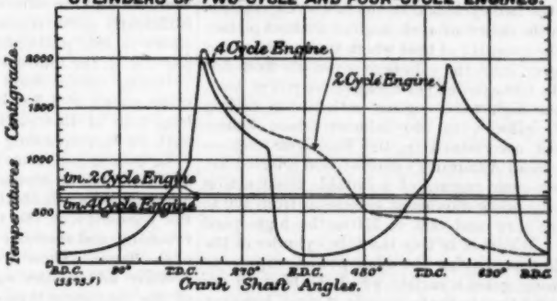

Ratio, Turning Moment. Mean Turning Moment.
Crank Shaft Angles.
Mean Turning Moment
Four Cycle Engine with 6 cylinders.
Two " " 4 "
Two " " 6 "

Fig. 6. DIAGRAM COMPARING THE TEMPERATURES IN THE CYLINDERS OF TWO-CYCLE AND FOUR-CYCLE ENGINES.



and space should be regarded as a secondary one, still the two-cycle engine shows the advantage that the particulars being the same, it can develop the same power as the four-cycle one at a much lower of speed of revolution, with the consequence of a reduction in the consumption and of a much better efficiency of the propeller. It is also very likely that as the consumption in the two-cycle engines has decreased, as a consequence of rational and systematic experiments, in a few years, from 250 grammes or 260 grammes per brake horse-power, to the present values, it will still improve until it reaches and even surpasses the low consumption of the four-cycle type. Theoretically there is no reason why this should not happen, for the thermal efficiency is the same in both types, and the power required by the two cycle engine cannot be greater than the power expended in driving the main pistons of the four-cycle engine to work half the time as pumps themselves.

Finally, besides the fuel consumption, that of the lubricating oil, which is much more expensive, ought to be considered. It is obvious that the two-cycle engine should require a less quantity of oil than the four-cycle, the load on the piston of the four-cycle engine being 50 per cent. greater (with the same number of cylinders and the same ratio between diameter and stroke) than that of the two-cycle, the pressure exerted on the bearings, and on the guides being proportionally increased, so that the surfaces to be lubricated are accordingly larger. In practice, however, as the two-cycle engine may be constructed with fewer cylinders the saving in the lubricating oil is still more evident. At present the figure of 3 grammes to 4 grammes (0·00614 lb. to 0·008818 lb.) per brake horse-power as the total amount of oil consumption is usually reached in high-speed engines (480 revolutions).

(*d*) As another advantage of the four-cycle type it is affirmed that the cylinder wall never reaches such high temperatures as in the two-cycle type, so that the latter are subjected to higher internal strains and thus to the danger of cracks. Now, whilst it is true that the ratio between the quantity

engines we may cite figures comprised between 203 grammes (0.447 lb.) and 210 grammes (0.463 lb.) per brake horse-power as resulting from the official tests of many two-cycle engines of the power of 350 brake horse-power at 480 revolutions and of 1,350 brake horse-power at 350 revolutions.

The following are the figures for consumption of fuel obtained in recent official tests on an Ansaldo San Giorgio engine of 1,300 h.p., 350 revolutions, furnished to an allied Government.

	Horse-Power.	Revolutions.	Gr.
At 4/5 of power ...	1110	292	194
At full power	1339	352	203.1
With 10 p.c. over power	1425	356	202.9

The consumption of lubricating oil was about 6 grammes (0.013 lb.) per horse-power per hour, although the lubrication was very abundant inasmuch as the motor was new.

The consumptions ascertained for the four-cycle engines are not much different; the data which have been published as to the slow marine four-cycle engines shew 182 grammes to 188 grammes cycle engines, but they can be safely overlooked upon consideration of the circumstances of the test or of the uncommonly high consumption of the lubricating oil, which was obviously partially burnt as fuel, so that the above-stated results can be quoted as corresponding to the best up-to-date constructions. Though they still show a slight advantage for the four-cycle engine, this is not greater than 3 per cent. or 5 per cent., and if we consider the other elements required for calculating the real working expenses, this difference is not of great importance. It must, indeed, be noted that the installation of two-cycle instead of four-cycle engines for a given type of ship, results in a saving in weight and space, and therefore a reduction of displacement and the possibility of increasing the run of the stern (this leading to a reduction in the power for propelling the ship at a certain speed). This advantage amply compensates for the slightly greater fuel consumption, specially in high-speed ships where the weight and the space taken by the propelling plant have the greatest influence. Furthermore, it may be added that, even if the question of the weight of the fuel burnt in the four-cycle type and the surface of the combustion chamber is hardly superior to one-half of the same ratio in the two-cycle engine, other important circumstances have been overlooked which have certainly a great influence on the mean temperatures.

The action of the hot gases on the cylinder walls lasts certainly a shorter time in the two-cycle than in the four-cycle type. Whilst in the latter the cylinder walls undergo the action of the hot gases during the whole expansion and exhaust strokes, that is, practically for more than half the time, in the two-cycle engine the action of the hot gases lasts only for little more than two-thirds of the working stroke.

In two-cycle engines in which the exhaust occurs through ports, the latter open much more rapidly than the exhaust valves of the four-cycle engines, and consequently there is a much more rapid diminution in the temperature due to expansion.

Whilst the exhaust temperature in four-cycle engines is seldom below 350 deg. C. and in the high-speed engines it easily reached 450 deg. or

500 deg. C., in two-cycle engines, if well constructed, this temperature usually remains under 250 deg. C., and sometimes it only reaches 200 deg. or 210 deg. C.

Taking account of this fact a diagram has been drawn of the relative temperatures of the high-speed four and two-cycle engines (Fig. 6), which has no absolute value but merely a relative one. It is based for both types on the same hypothesis, that is, volumetric efficiency 80 per cent., referring to air at the atmospheric pressure and at 15 deg. C., adiabatic compression from the initial temperature of 100 deg. C.; combustion at a constant pressure; adiabatic expansion, mean effective pressure 5 kg. per cm.^{2} for the four-cycle and 4·375 kg. per cm.^{2} for the two-cycle engine (corresponding to the ratio of 1·75 between the volumes of piston displacement); fuel consumption 198 grammes per brake horse-power for the four-cycle and 208 grammes for the two-cycle type; exhaust temperature of 450 deg. for the four-cycle engine (being the average temperature as ascertained in the high-speed engines presented at the competition of the German Admiralty above referred to). For the exhaust stroke in the four-cycle engine the curve of the temperatures is such as practically ascertained according to Dr. E. B. Wolff's experiments (see *Oelmotor*, 1915), where for the suction stroke a gradual mixing of the residual exhaust gases in the compression space with the atmospheric air has been assumed.

Not one of the hypotheses above referred to is in favour of the two-cycle engine; the hypothesis of the same initial compression temperature in both types is unfavourable for the two-cycle type, as all experiments which have been made with gas engines confirm that in the two-cycle engines a much higher compression ratio can be employed than in the four-cycle, without the danger of premature ignition, and that the mixture at the beginning of the compression is therefore cooler in the two-cycle type. By measuring the diagrams by a planimeter, however, the conclusion was reached that the mean temperature of the two cycles is practically the same.

The above result is confirmed by measuring the quantities of heat absorbed by the circulating water in the two-cycle and in the four-cycle engines. Whilst in the slow four-cycle engines without piston-cooling the quantity of heat which the cooling water carries away from the cylinders is usually from 580 calories to 650 calories per brake horse-power hour, and in the high-speed engines with piston cooling from 800 calories to 850 calories (these figures have been ascertained in the four-cycle engines of the German Admiralty's competition referred to), in the two-cycle engines of a suitable construction the corresponding number of calories is from 400 to 450 in the slow and 500 to 550 in the high-speed engines. Whilst it is true that the cylinder in the two-cycle type, having the same power, exposes to the burning gases a surface which is about 30 per cent. smaller than in the four-cycle, it must, however be remarked that the size of the cylinder of the four-cycle type being larger than that of the two-cycle, the thickness of the walls is consequently greater, and that a great part of the head surface in the four-cycle engine, owing to the presence of the valves, does not transmit any heat.

Taking account of all these elements it is fair to say that the two-cycle engine, from the standpoint of temperature, is in better condition than the four-cycle. The two-cycle engine, in which the inner walls of the cylinder, after the very short action of the flame, are immediately cooled by the scavenging air current (which is supplied in such quantity as to allow, besides the filling up of the cylinder, the escape of the warmest portion which entered at first) is thermally superior to the four-cycle engine in which all heat must be abstracted through the walls of the cylinders with the consequent fall of temperature in the walls and resultant internal stresses.

(*e*) The opponents of the two-cycle engine allege that in engines of this type some portion of the combustion gases remains in the cylinders, especially in the upper part of them, so that the cylinder head becomes excessively hot. Against this argument it must first be remarked that in the four-cycle engine at least 8 per cent. of the burnt gases remain and fill the compression chamber when the piston has completed its exhaust stroke, and it is obvious that this remaining portion cannot but contaminate the air which is drawn in during the subsequent stroke. As regards the two-cycle engine the assertion that some residue of the burnt gases still remains in the cylinder after the scavenging operation is merely a gratuitous hypothesis, which is contradicted by the facts above referred to, according to which the quantity of heat absorbed by the walls is less in the two-cycle engine, and that in the two-cycle type the compression ratio can assume a greater value than in the four-cycle engines.

During recent and accurate tests in the test-room of the Ansaldo San Giorgio works on a high speed two-cycle engine, it has been determined that the quantity of carbon dioxide contained in gas enclosed in the cylinder during the return stroke does not exceed 0·3 per cent., and that the contents of oxygen is hardly less than the content in the pure atmospheric air, *i.e.*, 20·5 per cent. instead of 20·9 per cent.

(*f*) Against the two-cycle engine it has been said that the four-cycle type can run with greater regularity than the two-cycle when working at low speed of revolutions, owing to the fact that in the two-cycle engine the compression at low speed falls rapidly with the diminishing of the scavenging air pressure. It must, however, be noted that this observation is correct merely when it refers to two-cycle engines of bad design, in which, owing to inefficient construction, the scavenging air pressure rises, at the normal speed, to excessively high value, whilst in two-cycle engines, which have been carefully designed, even at full speed the pressure of the scavenging air remains within very small limits. By the speed reduction the pressure is also somewhat reduced, but not so as to cause failure of the ignition especially when the engine is hot. Practically, in both the two-cycle and in the four-cycle types the lowest limit of speed is dependent upon the construction of the pulveriser, and this for the two-cycle engines is more than efficient for perfect manœuvring. Moreover, it must be remarked that the turning moment of two-cycle engines being more regular, and it being possible to run with half the number of cylinders and to obtain sufficiently good regularity, the two-cycle engine shows in this particular point an advantage compared with the four-cycle type.

During official tests the above-mentioned two-cycle engine of 1,300 brake horse-power ran for a long time at 45 h.p. (*i.e.*, nearly 1/30 power) and with the corresponding speed of 115 r.p.m.

In conclusion, it may be said that the two-cycle engine shows, as compared with the four-cycle, real advantages as regards the weight, the space required, the regularity of the turning moment, facility of reversing, and absence of organs subject to the action of the flame. These are important, undeniable and positive advantages against which the advocates of the four-cycle type can only oppose statements which are partly unfounded and partly not appliable to the system itself, but to some constructive details in defective engines built by inexperienced constructors. Judging by the tests and practical results of the two-cycle engines of good construction the writer holds that this type should become standard for the Diesel marine engines, as it is already for the hot-bulb engines.

Behaviour of Crystals in Liquid Air.—A preliminary account of experiments on the changes in physical properties which crystals undergo when immersed in liquid air is given by A. Johnsen, of Kiel, in the *Centralblatt für Mineralogie und Geologie* of August last. Hammer, cleavage, bending and scratch tests, &c., were made. In the case of Iceland spar, the hammer test (to produce cleavage crystals by blows) failed; artificially-produced cracks spread further than at ordinary temperature; a steel needle could only be forced into the crystal with difficulty. Gypsum and most other crystals showed a greatly reduced plasticity; there was little slipping of the crystals, but the conchoidal fracture was unchanged. Rock salt behaved similarly, but the cleavage power was not reduced. Crystals of metals—gold, silver, copper, &c.—also proved less plastic in liquid air; the blow merely flattened the crystals out, however, without breaking them. Muscovite (common potash mica) did not seem to mind the cold; thin and thick sheets could be bent as usually, and most tests gave the same results as at ordinary temperature.

LITERATURE.

The Zinc Industry. By Ernest A. Smith, Assoc. R.S.M., Deputy Assay-Master, Sheffield. Monographs on Industrial Chemistry Series. Edited by Sir Edward Thorpe, C.B., F.R.S. London: Longmans, Green and Co. [Price 10*s.* 6*d.* net.]

This contribution to the monographs of Industrial Chemistry is opportune and informing. The mind of the nation, hesitating between conflicting policies, is exercised concerning the proper attitude to assume towards the non-ferrous metal industries. Guidance and instruction are both necessary at this critical juncture, and the author brings forward many pregnant facts that should assist an intelligent decision and lead to resolute action. The recent debate in the House of Commons on this subject revealed a hesitancy inconsistent with exact knowledge, and a prejudice that may have been the outcome of ignorance or a loyal adherence to trusted shibboleths. The author's object is simply to present the condition of the industry in a correct light. He does not overload his case by perplexing details that must provoke discussion, nor does he urge heroic remedies for the removal of obvious defects. He is aware, painfully aware, of the lack of interest exhibited in this particular question, and he makes a serious and well directed effort to overcome the indifference that seems to have overtaken "manufacturers, users of metal, scientific investigators or students of metallurgy."

The metallurgical processes involved in zinc production on a commercial scale are of comparatively recent date. How recent and how sudden the development we had not appreciated till we studied Mr. Smith's statement. But so late as 1845 the world's production was limited to the modest amount of 29,000 tons, and even 30 years later the curve that demonstrates the rise and progress of the zinc industry showed but a very gentle upward movement. About 1873 "galvanising" attracted attention, and the curve rose rapidly. Other applications speedily followed, and in 1913, immediately before the war, the world required practically 1,000,000 tons to satisfy its various demands in commerce and industry. The output of lead was slightly more, while that of copper was nearly the same. This modern growth is rendered still more impressive if we examine the figures that express the advance in American production. In 1870 only some 4,500 tons were produced in the United States, a quantity that represented about one-thirtieth of the world's total. In 1913 the output had risen to 315,000 tons, or one-third of the world's production. Mr. Smith's diagram, which illustrates the growth or the fluctuations of the British share in the general increase, is not flattering to the national pride, or to the energy of the smelting fraternity. Though early statistics are not very trustworthy, in 1870 our output was apparently about the same as that of America at the same date, but instead of advancing it remained stationary up to about 1880, when, owing to the demands of the galvanising industry, the product rose to 30,000 tons, and for 20 years oscillated slightly on either side of that line. In this century there has been a noteworthy increase, necessarily checked by the outbreak of the war, but at that date our furnaces were supplying some 60,000 tons. This doubled output in 14 years may afford some satisfaction, but unfortunately it has to be admitted that for some years prior to the war, the imports of crude zinc into the United Kingdom averaged about 100,000 tons annually. The zinc situation is so critical and the dependance on foreign supplies constitutes such a source of danger, that, following the example of the author, who devotes a chapter to the future prospects of the British zinc smelting industry, we shall return to this subject later.

In some preliminary chapters the author gives a synopsis of the history of the zinc industry and of the available sources of supply of zinc ores. The story of the growth and development is not particularly cheerful reading. Perhaps it would not be too much to say that there is no branch of metallurgical industry in which, considering the difficulties and risks involved, invested capital has been more ill requited. This unfortunate circumstance is traceable in some measure to the limitation of

the smelting centres to restricted areas, a condition that tended to make the industry provincial rather than general. Conservatism has been fostered and undue regard paid to local tradition, with the consequent neglect of scientific control. The necessity of access to cheap fuel, the occurrence of a plentiful and suitable fireclay for the retorts, that play so large a part in the extraction, and the assistance of a specially trained and skilled labour, that seems to be the product of a distinctive environment, have all influenced the localisation of the industry. This last requirement of trained skill on the part of the workman has militated against Australian development at Port Pirie and other stations near the Broken Hill Mine, where labour and climatic conditions render any large extension of zinc distillation difficult or impossible.

The ores of zinc are widely scattered, and the life of some of the centres of production, as in China, is unknown; but there are at present no signs of scarcity, though the supply is not inexhaustible. The rich calamine, the natural zinc carbonate, long mined in Europe, is rapidly disappearing, and in the near future the whole of the zinc of commerce will have to be smelted from "blende," the once neglected zinc sulphide. Our domestic supply is small and we have long been dependent on imported ores. The total output of the United Kingdom is only 17,000 tons, of which about the sixth part is smelted in our own works, the remainder being exported.

In the description of the smelting processes, the author does not enter into technical minutiæ of manufacture, but the main principles involved are clearly indicated and the reasons for adopting particular procedure fully explained. The distillation method rendered possible by the volatility of the metal at a bright red heat, supplies by far the greater portion of the world's supply of metallic zinc. Two steps are necessary for the reduction. In the former the zinc compound in the ore is converted into an oxide by calcination or by roasting. The processes are generically different and the choice is determined by the character of the ore. The second operation of converting the oxide is so distinct from the former, that it is often convenient to conduct the two in quite separate establishments. The reduction is effected by mixing the oxide with crushed coal or coke and exposing it to a high temperature in clay retorts.

This general plan has remained unaltered since the foundation of the spelter industry at Bristol nearly two centuries ago, and the author can only describe improvement in detail. The introduction of gas producers and reversing regenerative furnaces of various kinds has economised fuel, the use of machine-made retorts of larger size and better design has given these a longer life. Vertical retorts with the promise of continuous smelting have been tried, rather than adopted, but will probably mark the next advance. The bugbear of the smelter is the inability to control the percentage of carbon dioxide, and the consequent oxidation of zinc vapour. But for this drawback blast furnaces would be at the command of the smelter, with considerable reduction in the cost of fuel and labour.

Modern science offers two alternatives to the older distillation process—electro-thermic smelting and hydrometallurgical methods. In the former method the distillation is continuous, being effected by heat produced within a reducing vessel or the furnace itself; in the latter the zinc is first dissolved and then recovered from solution by electrolysis. The electro-thermic process holds out the prospect of simplifying or dispensing with the roasting operation entirely, and of ensuring a continuous smelting process, though there are difficulties in discharging the residue as a slag that will flow. Unfortunately, however, the electric furnace contains an atmosphere comparatively rich in carbon dioxide, so that a larger amount of the powderous oxide is formed than in the retort furnace The method is on its trial and offers ample opportunity for the exercise of mechanical ingenuity. In the future the electro-thermic method may substantially influence the methods of zinc production, and introduces an important but uncertain factor in the development of the zinc industry.

In the hydro-metallurgical processes the zinc solution may be either a sulphate or a chloride, and the latter is said to be the more economical form of electrolyte, but in either case the determining factor in the choice of method is the cost of electric power. This consideration gives an advantage to the hydro-electric power plants of Canada and America where the general method employed is based on sulphuric acid leaching and subsequent electrolysis of the zinc solution, using lead anodes. Works at Great Falls, Butte, designed to produce 35,000 tons of electrolytic zinc annually, are in course of erection, and a slightly modified plan will be put in operation in the Mount Read district of Tasmania, where the ores present special difficulties for distillation processes, and the employment of hydro-electric power on a large scale is feasible. Considering the importance of these newer developments, a fuller description of the processes suggested, with illustrations of the arrangement of the plant, would have been of advantage.

Very useful chapters follow on the chemical and physical properties of zinc, attention being drawn to the use of the microscope as a means for determining the change of structure arising from varying mechanical or heat treatment, by examining the crystalline formation. In the case of industrial alloys wherein zinc finds large application, research has shown that the presence of small quantities of impurities, as lead, for example, can materially influence the result, and the demand for a higher grade metal than commercial spelter is growing. The whole problem of zinc alloys, whether in the form of "antifriction" metals or of brass, is of much importance, and is so well treated here that we regret to pass over these chapters with a bare mention of appreciation. The reproach has sometimes been levelled against the zinc industry that it has been slow to avail itself of modern improvements, whether initiated in this country or abroad. Mr. Smith combats this charge, but we are not so sure that the strictures are undeserved so far as smelting is concerned. It is, therefore, the more satisfactory to note the attention paid to a rigorous scientific control over alloys, pigments and bye-products generally.

It is impossible to resist the conviction that during the last few decades the zinc industry has tended to become more and more a German monopoly. Threatened by the ill-consequences of such a policy, whose malign influence was marked at the beginning of the war, Mr. Smith closes his review, as already intimated, by an examination of the steps, taken or contemplated, to counteract such ill-effects. If Great Britain is to produce all the zinc needed for home consumption, the pre-war output of metal will have to be increased fivefold, and this means the building and supply of much new plant with corresponding increase in the importation of ore. The advantages of such a plan are obvious, but so is the extent of the outlay, and the country apparently hesitates to accept the responsibility the altered conditions entail. There is plenty of ore within the Empire, and after the war, we may presume that the means of transport will again be forthcoming, but facilities for smelting and treatment do not exist. At the outbreak of the war the position of England was anomalous and humiliating. Little improvement has been effected since. With the command of the sea, and with an immense supply of zinc ore within the Empire, yet owing to the lack of smelting works, we were unable to provide the necessary metallic zinc for cartridge-brass and other purposes. But the experience of the past does not seem to be convincing, and a special Commission is still endeavouring to elaborate a scheme that shall reconcile vested interests with national requirements. Australia apparently has acted with generosity and decision, and, inspired by the example, the British Government has entered into a definite agreement for a term of 10 years, to accept annually 100,000 tons of Australian concentrates. To estimate the full bearing of this contract, we must remember that the actual home production in 1913 was only 58,000 tons and the consumption of virgin zinc some 224,000 tons.

This raises the question of the capacity of the smelting works. The Germans have been ousted from Swansea, and some extensions have been effected, but the total capacity is estimated to fall below 78,000 tons. The deficiency is evident, and it seems imperative that the Government should undertake the erection of new plant, or, as an alternative, fix a price for spelter that will stimulate private enterprise. The problem is pressing, and we believe that there is at present a greater quantity of Broken Hill concentrates in the country than can be conveniently handled. There is, too, a further question—the complete treatment of these ores involves a potential source of sulphuric acid, as well as of lead and silver from the complex ores. A restriction on the supply of sulphuric acid cannot be contemplated with equanimity. An industrial success of the first magnitude is within sight if enterprise and resource are exhibited. Ignominious failure follows on feeble initiative. The removal of a peril similar to that which threatened the country at the outbreak of war, all too imperfectly realised, would be sufficient justification for the acceptance of a new responsibility.

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THE 200-H.P. AUSTRO-DAIMLER AERO ENGINE.

We are indebted to the Technical Department for Aircraft Production for the following detailed report on the design, construction and general performance of the latest type of Austro-Daimler engine. This report is based on an examination and tests carried out at R.A.E. on the engine (No. 19,218) taken from a captured Austrian "Berg" scout. (R.A.F. No. A.G.6.) This machine, a single-seater biplane, brought down on the Italian front in April, 1918, was captured in very good condition; the engine had apparently only been in use for a few hours.

With the exception of its high stroke, bore ratio, and the construction of a detachable inlet valve seating in each cylinder, the design of this engine shows no great resemblance to the earlier types of Austro-Daimler engines; generally speaking, the new 200-h.p. Austro-Daimler possesses more than the usual amount of originality in design found in enemy aero engines.

The general construction of the 200-h.p. Austro-Daimler is shown in the two photographs of the complete engine, Figs. 1 and 2, and also in the accompanying general arrangement and cross-sectional drawings, Figs. 3 and 4, on page 489. Following the usual German practice, the engine is of the six-cylinder, vertical, water-cooled type with separate built-up steel cylinders. The principal characteristics of the design and its general performance are given in the following leading particulars of the engine:—

Number of cylinders	Six, vertical
Bore	135 mm.
Stroke	175 mm.
Normal B.M.E.P.	123.3 lb. per sq. in.
Average B.H.P. and speed	200 B.H.P. at 1,400 r.p.m.
Compression ratio	5.02 : 1
Petrol consumption per hour	111.0 pints
Petrol consumption per B.H.P. hour	0.555 pints
Oil consumption per hour	7 pints
Oil consumption per B.H.P. hour	0.035 pints
Total weight of engine, dry	723.5 lb.
Weight per B.H.P. (normal)	3.64 lb.

The compression ratio is considerably higher than that of any of the enemy engines except the Maybach, and from the complete data published at the end of this report it will be seen that the general efficiency of the engine is good, the horse-power per cubic foot of stroke volume being 377·3 and the horse-power per square foot of piston area being 216·6. During calibration and endurance tests carried out at R.A.E., the running of the engine was very good, being very steady between 700 r.p.m. and 1,700 r.p.m. The engine was remarkably clean, having no trace of oil or water leakages during tests.

Compared with the usual high weight standard of enemy engine design, the weight per brake horse-power of 3·64 is quite normal. From our own standard of weights, however, the weight per brake horse-power is disproportionately high. This is chiefly due to the heavy construction of the crank chamber and oil base, rather than to the design of the cylinders and reciprocating parts, which are well designed and are of light construction compared with other enemy engines.

General Description.

As a preliminary survey of the general design of the 200-h.p. Austro-Daimler engine, the principal features of the engine are briefly described in the following summary: The six separate cylinders are of the usual built-up steel construction with pressed steel water jackets, and are fitted with twin inlet and exhaust valves in the cylinder heads, which are integral with the cylinder barrels. The valve pockets are welded into position, with the exception of one inlet valve pocket in each cylinder, which is constructed so as to be easily detachable with its valve seating and guide, as in previous Austro-Daimler engines, so that all the valves can be removed without dismounting the cylinder. Aluminium pistons are adopted, and, with the exception of those recently fitted to the 230-h.p. Benz engines, were at the time of capture apparently the only aluminium pistons in use in enemy engines, although since this engine was captured a Rumpler biplane has been brought down fitted with a 270-h.p. Basse-Selve engine using aluminium pistons.

The H section connecting rods are of normal design and the crankshaft runs in seven white metal bearings, which are carried by the top half of the crank-case. The bottom halves of the journal bearing housings are steel forgings and are very deep in cross-section, being similar in design to the journal bearings fitted to the Maybach engines.

The design of the valve gear and camshaft drive presents several interesting details. As shown in the illustrations of the engine, the overhead camshaft is driven by a vertical shaft off the front end of the crankshaft. The camshaft runs in four phosphor-bronze bearings in the centre of an aluminium camshaft case. A compression release gear, very similar to the Mercedes type, is provided. The water circulation passage from the cylinders to the top of the radiator is taken through the front end of the cast aluminium camshaft casing, just behind the driving bevel gear.

A reciprocating plunger type oil pump is fitted in the front end of the oil base. This pump is driven by bevel and worm gearing directly off the crankshaft and is unusually heavy, but of interesting design. The lubrication is on normal principles and embodies a large air-cooled oil sump at the bottom of the base chamber, which is supplemented by an auxiliary fresh oil reservoir cast in the front end of the top half of the crank chamber. The fresh oil is delivered by a small auxiliary plunger, working in conjunction with the main oil pump, to the front end of the camshaft, the lubrication of which is well carried out. A "V" type honeycomb radiator is fitted directly behind the propeller, and the centrifugal water pump, which is driven obliquely off the rear end of the crankshaft, is of ordinary design.

Two Bosch Z.H.6 magnetos are driven diagonally at 52 deg. off the vertical camshaft driving shaft at the front of the engine, and two plugs are provided in each cylinder. The magneto controls are interconnected with the throttle control, so that the ignition is automatically retarded when throttling down. A heavy duplex carburettor feeds the cylinders through two separate steel induction manifolds, which are galvanised, and lagged with asbestos; each manifold feeds three cylinders. The carburettors are water-jacketed and heated by the cylinder water circulation system in the usual way. Main and slow-running jets are fitted, the two annular floats being housed in chambers surrounding the choke tubes. The main air intake is taken through a passage cast in the two halves of the crank-case, leading to the chamber below the false bottom of the oil sump.

An air pump of the spring plunger type is driven off the camshaft and is mounted on the top of the camshaft-casing towards the rear end of the engine. A transverse-shaft driven off the rear end of the crankshaft carries two cams for the synchronised gun interrupter gear. No exhaust manifold is provided, each cylinder being fitted with a short streamline section exhaust pipe about 12 in. long, as shown in the illustrations of the engine.

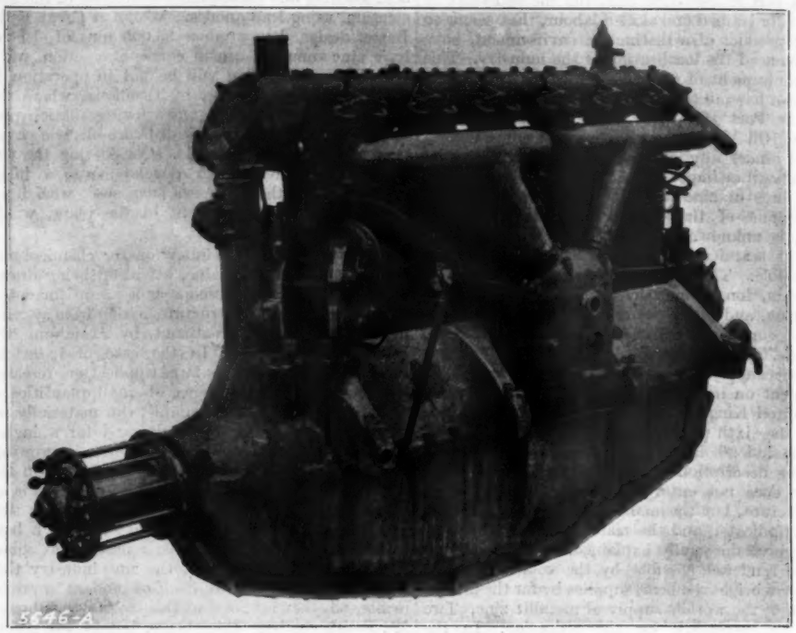


Fig. 1. 200 H.P. Six-Cylinder Austro-Daimler Aero Engine, Carburettor Side.

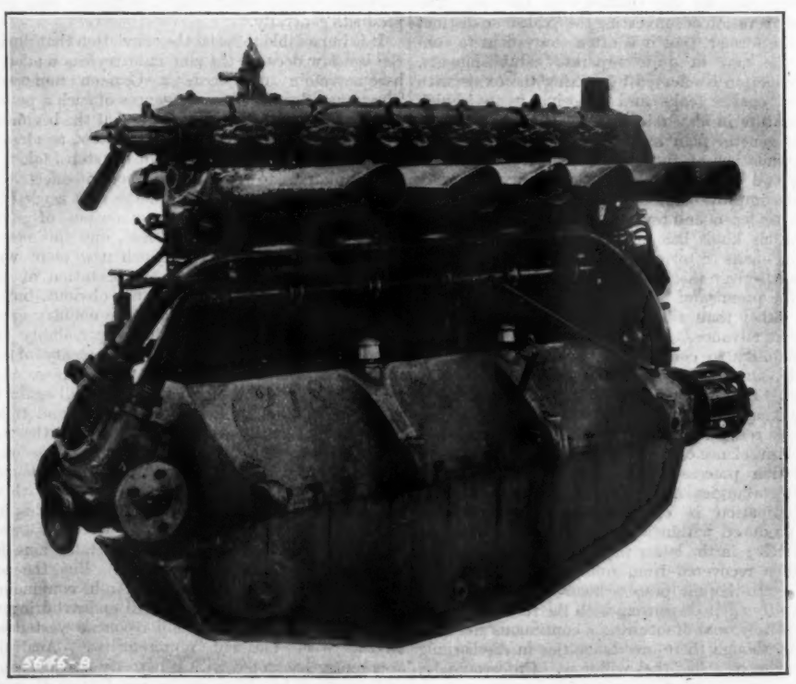


Fig. 2. 200 H.P. Six-Cylinder Austro-Daimler Aero Engine, Exhaust Side.

Details of Construction.

Cylinders.—The six separate cylinders are made entirely of steel. The cylinder barrels, which are integral with the heads, are built up of steel forgings.

200-H.P. AUSTRO-DAIMLER AERO ENGINE.

Fig. 3.

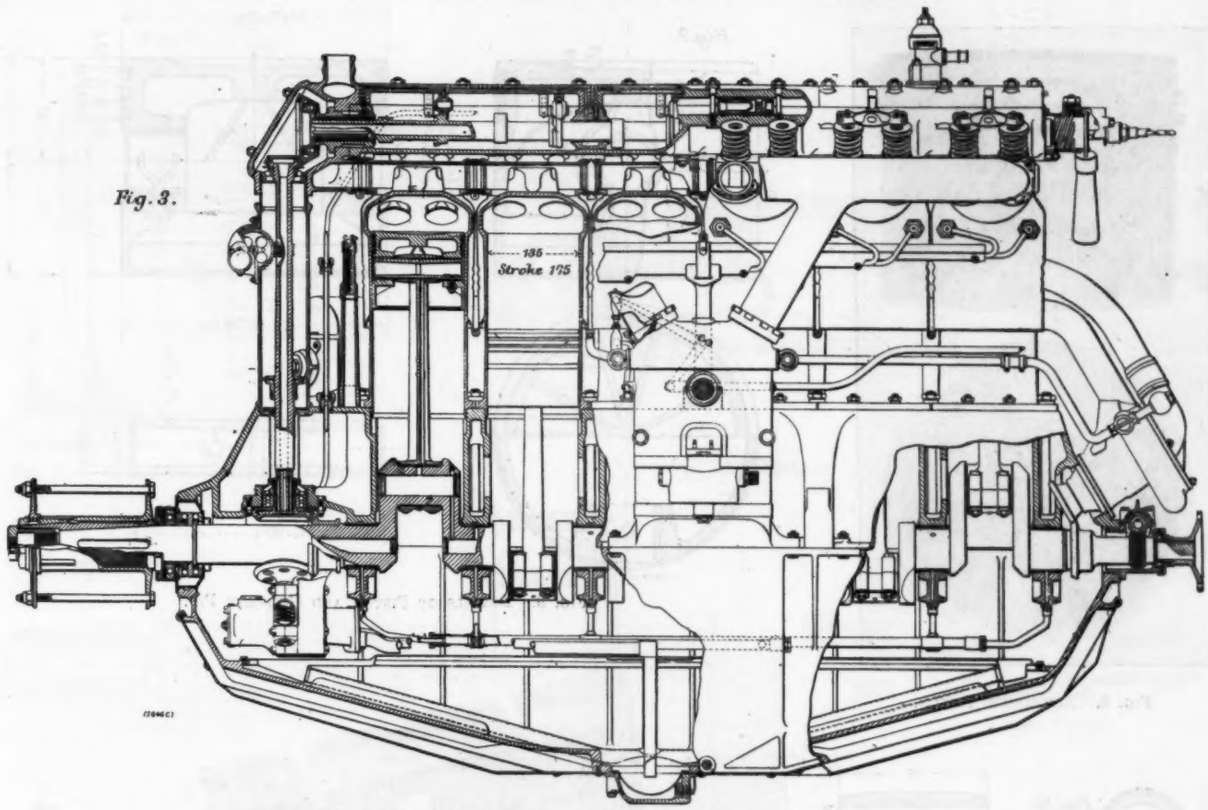


FIG. 3. GENERAL ARRANGEMENT OF ENGINE SHOWING LUBRICATION.

Fig. 4.

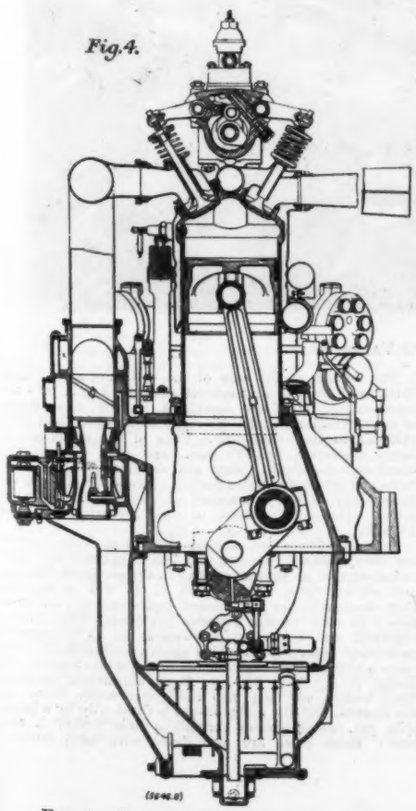


FIG. 4. CROSS SECTIONAL ARRANGEMENT.

FIG. 5. SECTIONAL VIEW OF CYLINDER.

Fig. 7.

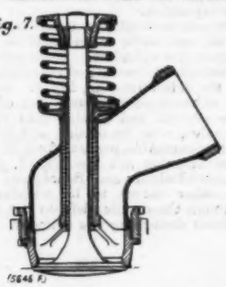


FIG 7. DETACHABLE INLET VALVE POCKET.

Fig. 6.

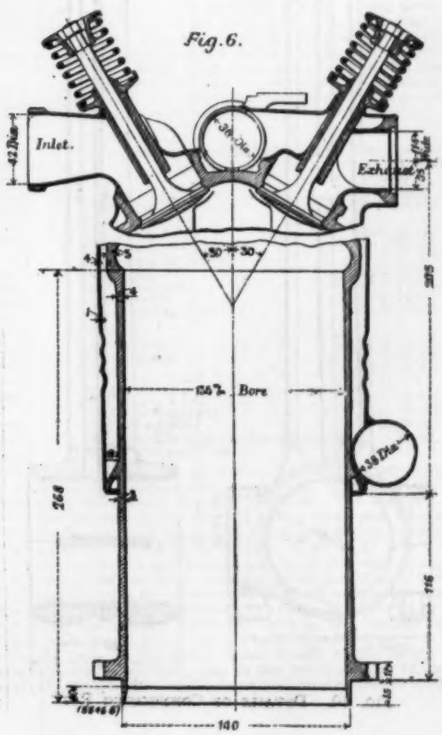


FIG. 6. DETAILS OF CYLINDER.

200-H.P. AUSTRO-DAIMLER AERO ENGINE.

FIG. 8. ALUMINIUM PISTON.

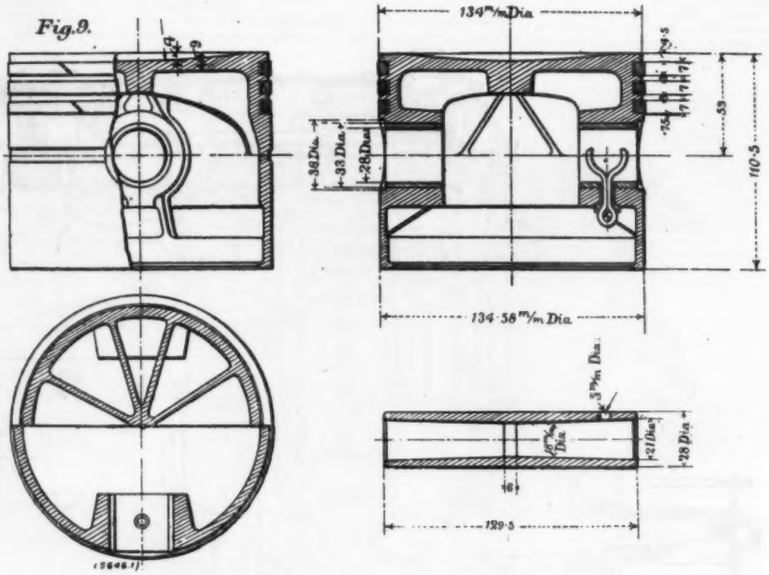


FIG. 9. DETAILS OF PISTON AND GUDGEON PIN.

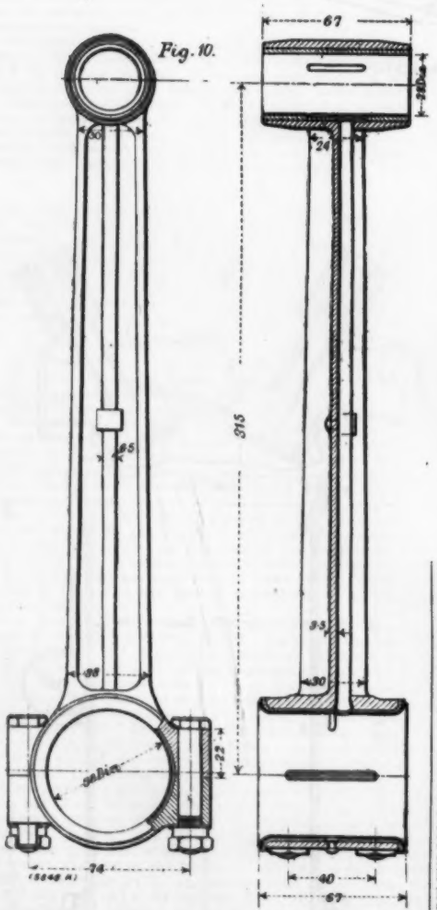


FIG. 10. DETAILS OF CONNECTING ROD.

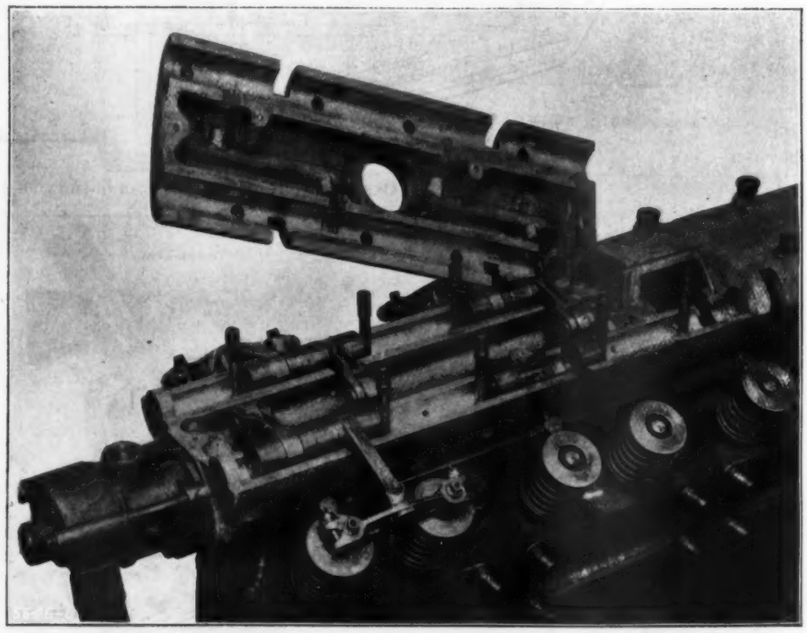


FIG. 12. VIEW OF VALVE GEAR.

The barrels are machined all over, and are ground to 135-mm. bore; the thickness of the cylinder walls tapers on the outside from 3 mm. at the centre to 4 mm. at the top, and 4 mm. at the base. The water jackets are pressed in the usual way from sheet steel 1 mm. thick, and are very short. The bottom of each water jacket is flanged over and welded to a bevelled flange, which is machined on the cylinder barrel, as shown in the sectional photograph of the cylinder, Fig. 5; three annular corrugations are formed in the water jackets to allow for expansion.

Two inlet and two exhaust valves are fitted in each cylinder head, and work at an angle of 30 deg. to the vertical axis of the cylinders. These are clearly shown in the cross-sectional drawing of the engine, Fig. 4, page 489, and in the detail drawing, Fig. 6. In each cylinder two of the exhaust pockets and one of the two inlet pockets are pressed and welded into the head. The other inlet valve, with its seating and guide, is carried in a separate detachable pocket, fixed in position by a large gun-metal union nut (see Fig. 7, page 489), as in previous Austro-Daimler and Beardmore engines. This allows the other valves to be withdrawn from the cylinder through the opening left on the removal of the pocket, without disturbing the cylinder.

The flanges at the base of the cylinders are 11 mm. thick, and the cylinder spigots extend 15 mm. into the crank-case. Lugs are machined in the base flange of each cylinder to take the eight studs which bolt each cylinder to the crank-case. Four of the studs are of larger diameter, i.e., 19 mm., and pass through the crank-case top-half; they act as main holding-down bolts and secure the lower portion of the journal bearings, thus relieving the crank-case of most of the working stress. The total weight of each cylinder, bare, is 18·4 lb.

Pistons.—These are of cast aluminium; the crowns are very slightly concave, and are supported by eight radiating ribs, as shown in detail in the sectional drawing and photographs, Figs. 8 and 9. It will be noticed that these ribs are not spaced equi-distantly, the two ribs over each of the gudgeon-pin bosses being closer together, and extending downwards so as to support each boss from below. This design undoubtedly provides a much better distribution of the stress than in the design of the new 230-h.p. Benz aluminium pistons. Steel bushes are cast into the gudgeon-pin bosses in the pistons, and the gudgeon-pin is fixed only by a large split pin, which passes through a hole drilled in the boss; these holes are also fitted with steel bushes.

200-H.P. AUSTRO-DAIMLER AERO ENGINE.

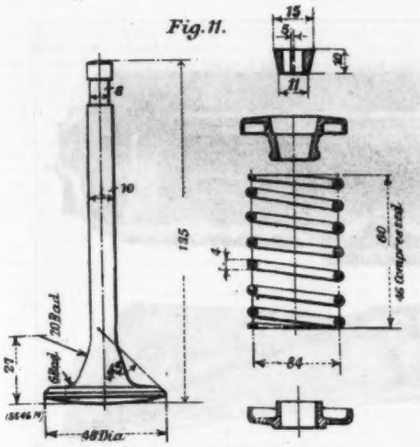


FIG. 11. DETAILS OF VALVE AND SPRING.

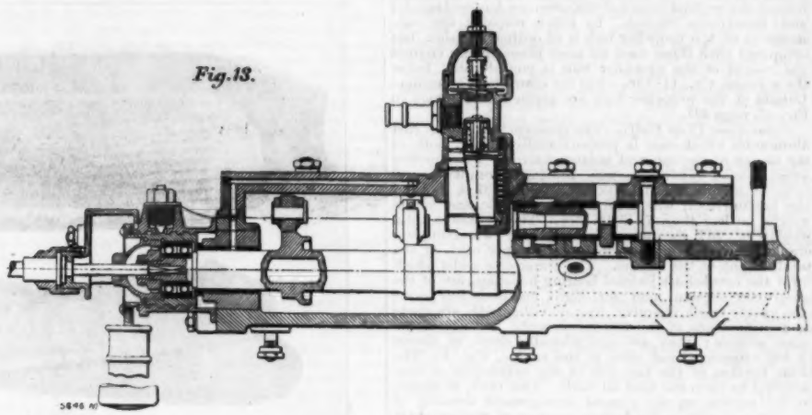


FIG. 13. CAMSHAFT AND AIR PUMP.

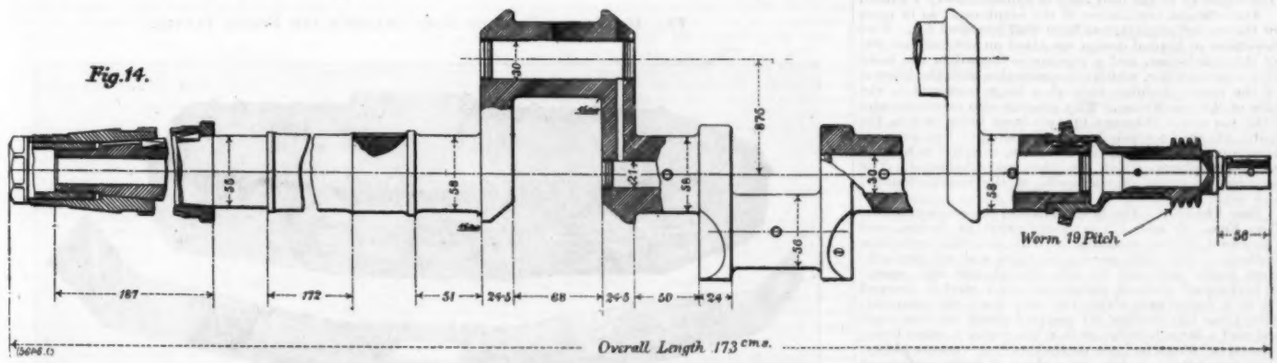


FIG. 14. DETAILS OF CRANKSHAFT.

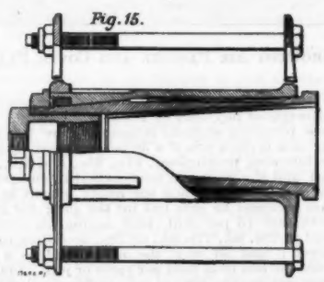


FIG. 15. SECTION OF PROPELLER HUB.

Three plain cast-iron rings are fitted above the gudgeon-pins, and an annular groove is machined around each piston on the gudgeon-pin level for lubrication. The weight of each piston is 3·52 lb. with rings, and the weight of each gudgeon-pin is 0·66 lb.

Connecting Rods.—The connecting rods (see Fig. 10) are of H section and exceptionally long for the size of the engine; from the German standard of weight they are of comparatively light section, but the central webs of the rods are not drilled. Four bolts are used to hold the halves of the big-end bearings. These bolts are 10 mm. diameter, and each pair is locked by a sheet-steel clip. The white metal lining of the bronze big-end bearing shells is 1 mm. thick, and the small ends are fitted with phosphor-bronze bushes for the gudgeon-pin bearings, which are lubricated by small diameter pipes attached to the central web of the rods in the usual way. Two horizontal oil grooves are cut in the lower halves of the big-end white metal bearings, and a short transverse oil groove in the top halves, whilst the small-end bushes are provided with three longitudinal oil grooves.

Weight of the complete connecting rod ..	= 4·84 lb.
Weight of big end	= 3.18 lb.
Weight of small end	= 1·66 lb.
Length of connecting rod between centres	= 315 mm.

Valves and Valve Gear.—The twin inlet and exhaust valves are all of the same dimensions and are interchangeable, and, as previously mentioned, work at 30 deg. to the vertical cylinder axis. The largest diameter of the valve heads is 48 mm., and the effective diameter is 44 mm., which gives a combined inlet valve opening area of 4·24 sq. in. The mean gas velocity through the inlet valves is 140 ft. per second. The general design of the complete valve gear is clearly shown in the sectional drawings, Figs. 3 and 4, and details of the valves and springs are given in Fig. 11. Single helical valve springs are fitted to each valve, and the valve spring collars are held in position by split cones, which register with the recess cut in the end of the valve stem, as shown in Fig. 11. This spring locking device is similar to that used in the Benz engines.

The valves are operated by a single over-head camshaft, which is carried in an aluminium case, running the whole length of the engine in one piece; this case is attached to each cylinder by two studs screwed into lugs formed in the cylinder heads.

The camshaft runs in four phosphor bronze bearings; these bearings are split and mounted in aluminium housings, and are located in the camshaft casing by small taper grub screws. The cover of the camshaft is in three parts, with very close joints; these detachable covers permit easy access to the valve gear of any or all of the valve rockers and cams. (See Fig. 12, page 490.)

Each valve rocker spindle is carried in three separate phosphor-bronze bushes, which are housed half in the lower portion of the aluminium camshaft casing, and half in the camshaft case cover. For ease of manufacture the boring of the cover and case is carried out as two continuous holes running the whole length of the case, and forming long semi-circular grooves in both halves, in which the valve rocker spindle bearings lie. These bearings are held in position by dowel pegs, and the centre bearing of each set is, of course, split.

With the exception of the bridge pieces, which operate the valve stems, the valve rocker levers are machined from single steel forgings, and the bridge pieces, which carry the adjustable tappet screws, are pressed and rivetted on to the ends of the rocker arms against a shoulder. The bridge pieces are prevented from swivelling by being let into a recess cut in the base of the shoulder. The ends of the adjustable tappet screws are hardened, and are fitted with the usual type of transverse locking bolt.

Hardened steel rollers are fitted to the inside arms of the rocker levers, and a deep oil groove is milled in the top of these arms to convey oil through the hollow spindles to the bearings and also to the cam rollers. Compression release cams are formed on the exhaust cams, and the lateral movement of the floating camshaft is effected by a long hand lever at the rear end of the engine. This lever is attached to a gun-metal collar, which is fitted with a square thread screw, the design of this compression release gear being very similar to that used on all the Mercedes engines.

The camshaft (see Fig. 13) is driven from the front end (which is quite unusual in enemy engines) through a bevel gear, which floats on eight splines cut on the end of the camshaft. The camshaft vertical driving shaft is driven directly from the front end of the crankshaft by bevel gears. The top end of the vertical spindle runs in a combined thrust and radial bearing, and the lower end (which has six splines cut in it) floats in the lower bevel gear, which with its bearing and housing forms a separate unit, and need not be disturbed when withdrawing the vertical spindle.

Crankshaft—	mm.	(in.)
Number and type of main bearings ..	Seven, bronze cage, lined white metal	
Cylinder centres	166·0	(6·53)
Journals—		
Outside diameter	58·0	(2·28)
Inside diameter (front two)	21·0	(0·82)
Inside diameter (others)	30·0	(1·18)
Length, prop end	56·0	(2·20)
Length, rear end	43·5	(1·71)
Length, centre	50·0	(1·97)
Length, intermediate	50.0	(1·97)
Crankpins—		
Outside diameter	56·0	(2·20)
Inside diameter	30·0	(1·18)
Length	68·0	(2·67)
Crank webs—		
Width	74·0	(2·91)
Thickness (front two)	24.5	(0·96)
Thickness (others)	24·0	(0·94)
Radius at ends of journals & crankpins	4.5	(0.17)
Weight of complete shaft	96·5 lb.	

Crankshaft.—The six-throw crankshaft is of normal design and requires little description. The usual type of plain white metal bearings are used. The diameter of the journals is 58 mm. and of the crank-pins 56 mm.; the length of all the journal bearings is 50 mm., with the exception of the front bearing, which is 51 mm. All the crank pins and journal are bored 30 mm. diameter, except the two front journals, which are 21 mm. bore; and the webs are drilled with 5-mm. oil leads in the usual way for pressure lubrication. Brass discs are used to plug the ends of the holes bored in the journals and crank pins. These are expanded into grooves cut in the ends of the holes. Other details of the design of the crankshaft are given in the drawing, Fig. 14, and the construction of the front ball bearing and propeller

double thrust race is clearly shown in the general arrangement sectional drawing of the engine, Fig. 3.

Propeller Hub.—The method of attaching the propeller hub by serrations cut on the outside of a sleeve which fits on to the tapered extension of the crankshaft, follows the original design of the previous Austro-Daimler and Beardmore engines. In other respects the construction of the propeller hub is of ordinary design, but compared with those used on most other enemy engines the weight of the propeller hub is considerably below the average, viz., 11·3 lb.—less the crankshaft extension. Details of the propeller hub are given for reference in Fig. 15, page 491.

Crank-Case (Top Half).—The construction of the cast aluminium crank-case is proportionally heavy, both in the design of the top and bottom halves. The top half weighs—with main journal bearings complete and cylinder holding-down bolts and studs—133·4 lb., and the bottom half, which forms the oil base and sump, weighs no less than 73·5 lb. dry. This makes a total weight of 207 lb., approximately, for the complete crank chamber, which works out at 28 per cent. of the total weight of the engine. The transverse webs which form the crankshaft journal bearing housings, are of the usual box section, and the eight engine-bearer arms cast on the crank chamber, four on either side, are made as continuations of the transverse webs, and are of the same section; they are exceptionally deep, as shown in the cross-sectional view of the engine, Fig. 4. The front portion of the top half of the crank-case is constructed to form the feed oil tank. This tank, as shown in the section on the general arrangement drawing of the engine, encloses the bottom portion of the camshaft vertical driving shaft, and is fitted with a filling cap and oil filter and also with a glass sight-level oil gauge. The capacity of the feed tank is approximately 1 gallon.

The efficient ventilation of the crank-case, as in most of the enemy engines, has been well provided for. Two breathers of normal design are fitted on the exhaust side of the crank-case, and a passage is formed in the body of the carburettor, which communicates with the interior of the crank chamber through a large port cast in the side of the crank-case. This passage also communicates with the crank chamber by two large holes cast in the webs of the central bearing housing; the primary function of this passage is, of course, to assist in heating the carburettors, which are also water jacketed. The average thickness of the walls of the crank chamber is 9 mm.

Base Chamber.—The bottom half of the crank chamber (see Figs. 16 and 17) is complicated in design, and excessively heavy, weighing 73·5 lb., complete with false bottoms. The walls are 6 mm. thick and are strengthened inside and out by ribs spaced 130 mm. apart. A perforated plate of galvanised sheet steel is screwed on to a flange cast about half-way down the chamber. This plate has shallow oil sumps formed on it at each end and a large hole cut in it in the centre; other holes, 25 mm. in diameter, are pierced in it in various places. Over this bottom is screwed a sheet of finely perforated steel, covered on the underside with very fine wire gauze. Below the filter plate the bottom of the base chamber slopes sharply to the centre portion, which is flat and has a small sump bolted on underneath it. Cooling ribs are cast on the two sloping portions, both inside and out; the sides of the base chamber are carried down 40 mm. below the bottom and a strip of sheet aluminium is screwed on to their lower edge, thus forming an air chamber along the whole underside of the engine. The aluminium plate has three air ports covered with wire gauze at each end. According to a report these ports are fitted with a vaned shutter.

The main air supply for the carburettor is taken from this false bottom through a passage cast in the side of the crank chamber. The purpose of the false bottom is to cool the lubricating oil and warm the incoming air.

(To be continued.)

Derby Society of Engineers.—The following gentlemen have been elected as office-bearers for the ensuing session: President, Sir A. Seale Haslam; chairman, Mr. W. Price Abell; committee, Messrs. C. G. Conradi, H. T. H. Edgecombe, G. H. Haslam, H. Matthews, W. H. Swift, A. Wormald; Hon. secretary, R. W. Reid; hon. treasurer, J. E. Anderson. The membership has now reached 240, and the financial position is considerably improved with a credit balance of 100*l.*

British Industries Fair, 1919.—For next year's British Industries Fair, the Board of Trade have again been able to secure from the Port of London Authority the great warehouses in Pennington-street which proved so highly satisfactory for the fair held at the beginning of this year. The fair will open as usual on the last Monday in February (February 24) and will remain open until Friday, March 7. In order in no way to interfere with the production of munitions, the fair will again be restricted to the same trades which have participated in the last three fairs, namely: Glass and pottery; paper, printing and stationery; fancy goods; toys. As in past years, the invitations to visitors to the fair will be issued by the Board of Trade and admittance will be restricted to *bona fide* buyers interested in the above trades. Over 2,000 forms of application for space have already been issued to manufacturers in the trades concerned, and it is expected that the number of firms anxious to participate will be considerably in advance of last year when orders to the value of over 1,500,000*l.* were placed. Eligible manufacturers who have not received application forms should, if they wish to participate, communicate at once with the Director, British Industries Fair, Board of Trade, 10, Basinghall-street, London, E.C. 2.

200-H.P. AUSTRO-DAIMLER AERO ENGINE.

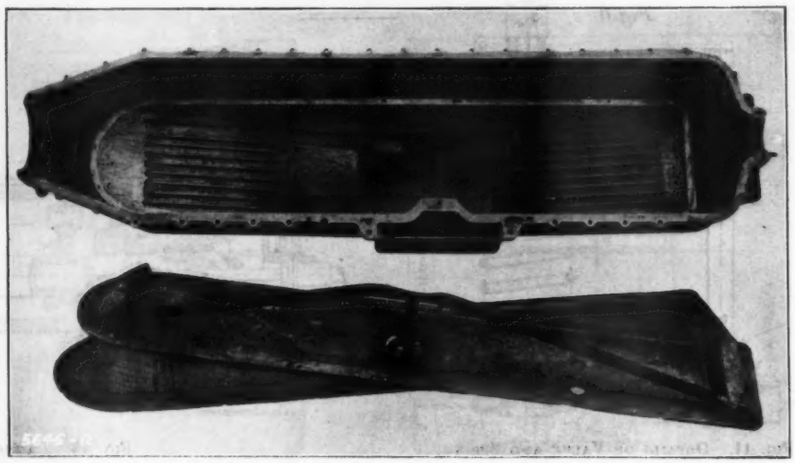


Fig. 16. Inside View of Base Chamber and Filter Plates.

Fig. 17. View of Base Chamber from beneath, showing Air Passage and Cover Plate.

THE WORKER, THE EMPLOYER, AND THE UNSOLVED PROBLEM.

To the Editor of Engineering.

Sir,—The article under above heading in your issue of October 18 is, in my opinion, the most lucid, fair, sensible statement which I have seen or heard on the labour question. Every point made might be enlarged upon, but each is so effectively given that it is difficult to say which is most important. As, however, the whole article relates to industrial progress in the national interest and as our most essential trades will in future have to cope with extraordinary competition from sources hitherto negligible—Mr. Hurley, chairman of the United States Shipping Board has stated that 25,000,000 tons of merchant ships were being built in America under present programme; 3,000 vessels, mostly modern steel steamers; 160 new ships have been started; and it is the intention of America to develop their present shipbuilding activity—a few remarks on the available means of attaining better results may be pertinent.

Although the problem of capital return and labour remuneration is very involved, and may be insoluble, it is now admitted that a basis must be arranged upon which a reasonable and mutually satisfactory agreement can be reached.

After the war, no matter what the state of trade may be, competitive conditions must be resumed; and in view of the present artificial position, the unsatisfactory relations between employers and employees will be intensified, unless measures are adopted to avoid serious trouble. The precautionary course of increasing workers' earnings by giving them war bonuses, may, and probably will, prove ineffective as a way of reverting to peace standard wages. A demand will certainly be made, at an early date, to revise minimum wage rates, and this question alone will severely tax the faculties of those most directly concerned. The subject of payment by results is sure to be brought forward simultaneously, and employers so far have no agreed plan formulated. This deficiency is bound to aggravate the situation if steps are not now taken to arrive at a decision which will accord with aspirations and so pave the way towards amicable relations.

There are at present several schemes proposed, and, while all of them fix wages differently for the same job, in each case it is claimed that the system gives effect to the principle of payment by results.

These premium systems suggested show the value of labour on a certain job, if a 30 per cent. saving is made, in the following proportions, 91*s.*, 85*s.*, and 80*s.*, respectively; and if a worker is more expert or energetic than others and improves upon the above output in respect of time occupied he gets less for the job; for instance, for a further 15 per cent. time saving his payment is reduced to 79*s.* 9*d.*, 77*s.* 6*d.*, or 70*s.*, according to system employed; and so on; the more efficient a worker becomes the less he is paid per piece or job. Under each of these systems the onus of rate-cutting is placed on the worker. Rate-cutting on the part of employers is generally admitted to be reprehensible, and it is difficult to see how the practice can be supported if the responsibility is shifted. It should also be observed and strongly emphasised that rate-cutting created output restrictions, so that if this effect is to be overcome the cause must be removed. These premium systems are nearly related to output restriction methods, and the fact that they have received some approval indicates the necessity of setting the question of "payment by results" on unequivocal lines. The inconsistency of advocating such premium systems when these are contrasted with Admiralty contract profit procedure—namely, 10 per cent. on estimated cost, plus 10 per cent. to 20 per cent. of the amount by which the actual cost is less than the agreed estimated cost—is obvious. Premium plans, like the fore-mentioned, are bad substitutes for "payment by results," and ought to be rigorously condemned as unfit for serious discussion. Unfortunately, certain firms appear to have deluded themselves that these bogus premium stunts will promote amicable relations, whereas, not a single trade union has given any of them satisfactory recognition; and it does not require the gift of prophesy to foretell that none of them will weather any scheme of reconstruction.

The only scheme, so far known to the writer, deserving to rank as a sound "payment by result" effort is that instituted by Messrs. Priestman Brothers, Limited, Hull. By their method, if the workers increase output over a fixed standard they are paid standard rates plus additional percentage corresponding with extra output percentage—not a 25 per cent., 12½ per cent. or 8·3 per cent. premium (?) for a 33⅓ per cent. increased output. Also, all employees participate on the same scale, and

therefore the main principle enunciated by trade unionists, so far as they are concerned, namely, distribution of work and wages, is, to some extent, allowed. The system is the acme of simplicity, and its merits are so self-evident that few words are necessary to describe it, or to tell how very favourably it has impressed all those immediately concerned, and also those who have examined it *apropos*. Mr. Wilfred Hill, of Birmingham, one of the signatories to the Whitley Reports, addressing the members of the Hull Chamber of Commerce recently, said "that he had examined many undertakings which had for their object the settlement of unrest in labour (the uniting of Capital and Labour), but of all the schemes he had looked into, that in operation in their own city"—Mr. Hill referred to the Priestman System of Payment by results—"was decidedly the best." Further, even "premium bonus" partisans who have commented on the Priestman system, so far as I am aware, do not adversely criticise the plan. Several, however, suggest difficulties in adapting it to meet general conditions, but those who do so, almost invariably disclose a lack of resource. Methods of adaptation are easy and as simple as the system itself.

The frank, fearless, prompt attitude of President Wilson, as expressed in his replies to Germany's armistice proposals, is an excellent example of the course which should be followed by us in dealing with payment by results. Diplomatic subterfuges—common to politics and trade—are obsolete, and it is pathetic to have to acknowledge that, while Mr. Wilson could face a decision involving the destiny of the world within 24 hours, British industrial progress has been retarded for years by quibbling about when and how the admitted principle of payment by results can be realised.

Propaganda, suggested by Mr. Ramsay, is desirable, but for heaven's sake not the Kultur variety—whining about the shortcomings of the other side and the virtues of the opposite.

Yours faithfully,
W. J. Grosart.

London, October 29, 1918.

"COAL SAVING BY SCIENTIFIC CONTROL OF STEAM BOILER PLANT."

To the Editor of Engineering.

Sir,—"Get a Move On" still sticks in the groove that a lot of other people are in by suggesting that the "only" way to save coal is at the furnace.

If he took a broader view he would recognise that this is only one place of many where coal could be saved, and which should be known to every engineer who has to do with the combustion of this material, that is if they are worthy of being classed as engineers.

The composition of coal is something we cannot alter. From a heating point it consists of the units of heat that can be extracted from the carbon, hydrogen and sulphur, less the effect of oxygen that is in the coal. Providing sufficient oxygen is supplied together with the necessary temperature for combustion, all these elements give off a certain fixed number of heat units that no one can alter. It is our duty to make the best use of them by ensuring that they do not go up the chimney either with an excess of air, or a reduction of this mixture.

The temperature of the furnace is just as particular as oxygen admission, more so with coals containing a high percentage of volatile matter, otherwise the gases will not take up their volume of oxygen but will condense and stick like so much tar on some of the so-called heating surfaces, like some of the faddist ideas that have been brought forward as additions to boiler plant; at the same time this creates excessive smoke, &c. This proper combustion can only be ensured in a fire-brick chamber, and I am sure that better facilities are offered in water-tube boilers for this purpose.

I need only mention that practically all electric power stations which have low generating costs are equipped with water-tube boilers for generating the steam. Not only that, but these boiler furnaces offer facilities for the combustion of practically any low-grade material that could not be consumed in a Lancashire boiler.

I have no doubt that water-tube boilers are the salvation of many of our plants to-day where we have to make the best use of material that is called coal, but which a few years ago formed quite a prominent part of the smoky refuse heaps at collieries.

Again, your correspondent takes a very narrow view on this matter when he says that the water-tube boiler is impossible for collieries, &c.

Perhaps this is one of the reasons why collieries show the lowest efficiency in the country; however it may interest him to know that modern collieries do have water-tube boilers and many recognise that there is something in being economical with their fuel, even if they use low-grade material or semi-slush from the washeries. If necessary I could give him many instances of collieries using these boilers.

It is essential to have some tell-tale apparatus such as CO_2 recorders, or Orsatt gear, but before these are of any use you must educate your firemen. I not only admit this, but for years I have been advocating it. If "Get a Move On" would let me know how, I would post him some printed proof of this.

The letter of Mr. Casmey's, following mine on the 18th inst., gives quite a vivid proof of the necessity for education of the stokers. Firemen as a rule are a class of men by themselves, and it is no use trying to drive them to execute economy; generally when you get to know them, you can lead them in a certain way, and I find that the best way is to mix up with them much more than is usually done in the stokehold. I give little lantern demonstrations to our men on subjects relating to their work, and I am agreeably astonished at the interest they take and also the creation of good feeling that is caused through this simple method of sociability. I strongly recommend the idea to others, I am sure they would be amply repaid. It would be a pleasure to me to repeat those lectures within any reasonable distance, providing it did not interfere with my present duties.

The transport of coal does not interest your correspondent. Well, he is a Yorkshireman, he is alongside the coal mines, but we in and around London can tell him that the transport of coal is one of the most serious questions and one of the principal costs of this material to-day. However, I will leave it at that just now, and tell him some plain facts regarding a small plant of two boilers, a few pumps and some hydraulic cranes. I mention this particularly as they occurred ten years or more ago and several other people have benefited from the facts. It may be interesting to others to-day when it is impossible to secure the plant and recording instruments one would desire.

There was a water meter on the works, and coal could be accurately weighed, in addition each pump had revolution counters. For a general test it was found out how much coal and water was being used for a certain tonnage discharged by the cranes, and also how many revolutions of the pumps were obtained per pound of fuel burned (pumps were of a fixed load). The result was that 596 tons of coal were consumed at the boiler-house (a standard coal) for a certain amount of coal discharged by the cranes. A lower unit was employed for the water used, which in this instance equalled 15,000 gallons.

No alteration whatever was made to the boilers or method of firing—we had fairly good men who were well up to the work of stoking, the only new order we gave them was to make the working pressure 10 lb. below the safety-valve adjustment and under no circumstances was the safety valve to blow-off excepting in case of emergency and also once during each shift as a trial.

The power-house was tackled, and every conceivable means were used to prevent loss by condensation, drains were closely looked after, traps and clean drains were led to feed tank, so also were the various receivers; thus not only was the feed-water temperature raised a great deal, but we also had quite a considerable amount of water free from impurities.

Greasy drains were run to another receptacle and from there were utilised as make-up water for the hydraulic cranes, incidentally making the opening and closing of the operating valves much easier, and at the same time preventing the scoring and consequent leakage of these valves, so much that instead of overhauling them weekly as was necessary, we could let them run months without these being so bad as previously. Condensers were closely looked to and broken pipes were discovered 16 ft. in the ground; these were patched up and replaced, and altogether quite a lot of apparently infinitesimal losses were remedied.

It took six months to do this work in the odd times that the men had themselves between the discharge of the vessels, after which tests were again made with the same coal as before, when the result worked out for the same tonnage discharged a decrease from 596 tons of coal to 330 tons, water was reduced from 15,000 gallons to 2,200 gallons.

I mention this case as all the material necessary to do this cost less than 10*l*., and consisted of a few lengths of various size wrought-iron pipes. At a meeting of the Institution of Mechanical Engineers this place was quoted as the most economical hydraulic power production works.

Many further economies have been effected since the above, particularly in relation to the use of power after it is generated, principally in the size of rams, some of which have been reduced to less than half of the original area, with an ultimate increase of speed, owing to better design of valves whereby the back pressures have been reduced. As these designs have been in use for over fifty years, look at the amount of hydraulic plants there may be in use with this wastage of power. If you only save 1 per cent. of the actual power used on the machine doing the work you will save 10 per cent., or even more, of your coal.

From this I hope to be forgiven for stepping once more beyond the boiler-house wherein the scientific control—the use of scientific instruments, education of stokers, and many other things, which will be impossible to get until we win this war—has no stronger advocate than

Yours faithfully,
John H. Anderson.

Purfleet, Essex, October 26, 1918.

To the Editor of Engineering.

Sir,—In Mr. Brownlie's report which appeared in your issues of July 12 and 19, the average size of the 1,000 boilers tested is given as 30 ft. by 8 ft., grates 6 ft. long, coal consumption per square foot of grate per hour 21 lb., CO_2 7·6 per cent., which equals 31lb. of gases per pound of coal burned, average boiler efficiency 56·7 per cent. As pointed out in a previous letter, these figures indicate a direct fuel loss of 14 per cent. due to excess air and indirect losses brought into operation through this cause would not be less than 6 per cent., making a total preventable loss of 20 per cent. Some of your correspondents appeared doubtful, and naturally so, as to whether or not Mr. Brownlie's figures could be taken as representative of the steam plants throughout the country; my own experience during the last four weeks has more than satisfied me on this point, and may interest some of your readers.

Since the beginning of October, I have been called out to report on five steam plants, the total number of boilers working was 30, the majority of them being 30 ft. by 8 ft. and 30 ft. by 8 ft. 6 in., and out of that number only three were giving anything like reasonable results, the average efficiency being 60 per cent., although burning from 42 lb. to 45 lb. of coal per square foot of grate per hour, CO_2 11 per cent. Of the remaining 27 boilers, 4 were burning 24 lb. of coal per foot of grate, average efficiency 48 per cent., weight of air per pound of coal 32 lb.; 16 gave an average efficiency of 46 per cent., coal consumption per foot of grate 19 lb., weight of air per pound of coal 31 lb.; and in the rest of the boilers the CO_2 was only 5·5 per cent., which equals nearly 44 lb. of air per pound of coal under which conditions the efficiency would be very little over 40 per cent., in this last range of boilers, one of them had fire-grates 7 ft. 6 in. long, and yet the boiler was only 7 ft. 6 in. diameter.

The poor results throughout are almost exclusively due to bad furnace conditions, i.e., too much air, this being caused through the fires being too long and too thin. In each case with the exception of the first three boilers mentioned, the advice given was to reduce the length of the grates until the ratio of 2 to 1 between grate and outlet from furnace flues was reached. I estimate the total coal saving on these boilers will be about 8,000 tons per year.

To secure the best results from coal, the correct weight of air for chemical union must be provided, and is it not therefore a practical proposition to proportion the size of grate to that of the outlets; through which the gases must pass, and thus enable each square foot of grate in whatever size of boiler to do the same amount of work.

Yours faithfully,
W. H. Casmey.

Milnthorpe, Wakefield, October 29, 1918.

PATENT LAW REFORM.

To the Editor of Engineering.

Sir,—Apropos of the criticism which appeared in the columns of Engineering of the two proposed new Bills, i.e., the Trade Marks Bill, and the Patents and Designs Bill, 1917, towards the end of last year and during the present year, it may be interesting to your readers to know that these Bills have now been withdrawn and are dead.

As the result of the question being raised conferences were held in the larger cities of the Kingdom which culminated in the formation of a General Committee in London which ultimately adopted a comprehensive report drawn up by the Institution of Electrical Engineers for presentation to the President of the Board of Trade. By arrangement a large and influential deputation consisting of doctors of science, inventors, electricians, patent experts, and representatives of technical and scientific societies and of some of the principal progressive industries in this country, was formed and appointed to wait upon Sir Albert Stanley to place before him its views on the imperfections of our patent system and the grievances under which inventors in this country suffered. It was ultimately settled that Sir Albert Stanley would receive the deputation on Thursday, the 10th inst.; the members of the deputation met at the Institution of Mechanical Engineers on the afternoon of that date and proceeded to the Board of Trade; it was rather unfortunate, however, that though the meeting had been arranged for with Sir Albert a considerable time ahead and even after the day and hour had been confirmed and definitely fixed, the time of meeting was put back one hour at Sir Albert's request by telephone, he, Sir Albert was not present, but sent a deputy in his place, much to the regret of the deputation, many of whom had come so far to lay their views before the Right Honourable Gentlemen on a matter so important to "*the commerce and industry of the country after the war*," upon which Sir Albert had been lecturing lately throughout the United Kingdom.

Some of us, old enough to remember being present in the same room in 1883 when the late Mr. Joseph Chamberlain, as President of the Board of Trade, met a somewhat similar deputation and eloquently spoke to us on the benefits of invention and its encouragement, and just before introducing his own revolutionary Bill of 1883, could not very well help comparing our reception *then* and *now*, with so much more at stake in competition after the war.

Anyone who knew the late Mr. Chamberlain with his proud, imperial and patriotic spirit, and who magnified every public office he ever held, could scarcely conceive his delegation of the reception of any such representative deputation to a deputy. Apart from that, however, the deputation were led inferentially from the chair to understand that no new Bills had yet been drafted, while the various speakers of the deputation urged with considerable force, an automatic moratorium or prolongation of patents to meet war conditions, the protection for inventions relating to food, medicinal or surgical products, the importance of product claims to chemical and other industries, the extension of (*a*) the term of patents, (*b*) the period of provisional protection, (*c*) the period of acceptance of the complete specification, the reduction of patent fees, the protection of patentees in relation to utilisation of their inventions by the State, the limitation of provisions for revocation of patents, the abolition of the compulsory working of patents which principally benefited foreigners and especially Germans, the safeguarding of patents of addition, the formation of a special tribunal to deal with patent cases, and the adoption, if possible, of a British Empire patent system. In regard to the latter, Sir Robert Hadfield graphically pointed out the absurdity of the present Canadian patent system (part of which system was incorporated in the proposed Bill last year) under which he found he had to pay the sum of eight guineas for a typewritten copy of a Canadian specification while the British printed specification of

same only cost here some 2½*d*. As regards the moratorium, patentees do not want any one-sided favours, but they desire justice. In my own knowledge there are patents for apparatus, say, for street and other lighting, &c., on which renewal fees are being regularly paid which have been turned into dead letters by the Government war restrictions, and surely it is only fair that an extension of time should be given these in the proposed new Bill? Then as to the necessity for compulsory working clauses, why should these be required here any more than in the United States unless to prevent us getting so good terms from other countries as the Americans do get because they have no compulsory working under their more perfect patent system? Unquestionably, our principal competitors after the war (Germany let us hope being barred) will be our American friends, and it is very desirable in the interests of invention, commerce and industry in this country, that we should have equal opportunities with our American Allies to say the least. We were promised by the Board of Trade representative that all these various matters would receive the earnest consideration in the preparation of the new Bill, but, to my mind—the end of the war being now at least in sight—the question comes to be, would it not be better now to wait till the war is over, and then if possible, secure a new Bill on American lines, formed on democratic principles to suit our conditions for the whole British Empire, in order that Britishers here and throughout the Dominions could have an opportunity of assisting us to hold our own in the race for the coming world's business.

Yours, &c.,
JAMES KEITH.

Highlands, Vernon-road, Leigh-on-Sea,
October 12, 1918.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read, with interest, the letter of "Senior Draughtsman," in your issue of the 25th ult., and am pleased to note his desire to amalgamate the whole forces of labour. But would it not be advisable for the A.E.S.D. to first set its own "house in order." At present, the rules require that any member of the association who leaves the drawing board, or its kindred office employment, shall cease after six months to be an *active member* of the association. He may, however, be relegated to the list of *past members*.

Surely before the A.E.S.D. talks of amalgamation with other bodies, it would be as well to amalgamate its own organisation, and not throw on the "scrap heap" some of its most ardent supporters and well wishers, simply because they have had the "good" or "ill" fortune to leave the drawing board for some other equally important phase of engineering or shipbuilding work.

If the A.E.S.D. fear victimisation from its members who have, perhaps, received promotion in their profession, surely it would be a simple matter to expel such a member immediately evidence was received that he had used his position to coerce his fellow members. This narrow-minded policy, as evidenced by the existing rules of the A.E.S.D., is surely not the true spirit of the draughtsman, and will, I fear, unless modified, cause the association to lose the support and goodwill of a large number of its most successful members.

Yours faithfully,
"A MEMBER."

Portishead, Somerset, October 29, 1918.

MAXIMUM PRICES OF SULPHURIC ACID.—An Order will shortly be issued by the Minister of Munitions fixing as from to-day new maximum prices for sulphuric acid, in place of those fixed by an Order dated May 10, 1918. Any communication in reference to the new Order should be made to the Director of Acid Supplies, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, S.W. 1.

HONOURS TO NAVAL ENGINEERS.—The following honours have, with the approval of His Majesty the King, been conferred upon naval engineers, among others, for services in submarines:—To receive the Distinguished Service Medal, Engine-room Artificers P. H. Biddle, Frederick Heron and Richard Honeywell. Chief Engine-room Artificer T. A. Hobson has been Mentioned in Despatches. For zeal and devotion to duty in the Mercantile Marine, the following have received an Expression of Commendation: Chief Engineers W. H. Fraser and Samuel Warne, Senior Third Engineer A. T. Johnstone, and Third Engineers R. Aitken and W. J. Tawse.

ENEMY AIRCRAFT EXHIBITION.—The exhibition of enemy aircraft at the Agricultural Hall, Islington, will, early next month, be thrown open to the public, who will be able to inspect numerous types of German aeroplanes which have been brought down by our gallant pilots, and are now re-erected so as to show, not only their external features, but also their actual construction. Amongst other famous machines on view may be mentioned the Gotha, Friedrichshafen and A.E.G. bombing planes; the Halberstadt, L.V.G., D.F.W., Rumpler and Hannoveraner two-seater, the A.E.G. armoured trench fighter two-seater, and the Fokker (biplane and triplane), Pfalz and Albatross scouts. There is also a complete array of engines and accessories, including wireless gear, machine guns, bomb-sights, electrically-heated clothing and innumerable aviation instruments. A charge will be made for admission, and this will be devoted to the R.A.F. Hospitals Fund.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Although little change falls to be recorded in connection with the manufacture of steel, the activity of production is intensified from day to day, and the pressure for delivery increases, the home demands being insistent, especially for shipbuilding requirements—shapes, sections and plates. Contrary to expectation export is still very small, and, notwithstanding the fact that licences are more easily procurable than they were for some considerable time, nothing is really going out of the country with the exception of a certain tonnage of finished steel shipped to the Allied Governments, chiefly to France. Many inquiries are coming to hand from neutral countries, but in the meantime manufacturers are not in a position to deal with these, owing principally to Government restrictions. The coal problem continues one of grave anxiety.

Malleable Iron Trade.—It is questionable if any of the allied industries are more actively employed at the moment than is the malleable iron trade—so great, indeed, is the demand that only high priority claims can be dealt with by the makers—all work must be, directly or indirectly, of national importance. The rolling mills are running incessantly, and even with this it is scarcely possible to avoid deliveries falling into arrears, the demands both on the iron and the steel departments being constant and heavy. In the iron department, for instance, the rivet works are taking up large quantities of bolt and nut iron, while in the steel department there are urgent requests for light rails for trench work, these requirements alone being sufficient to keep every establishment busy.

Scotch Pig-Iron Trade.—The pig-iron market continues firm, the demand for all brands being still on so large a scale that the entire production is speedily absorbed. Government having first claim on hematite, none is available for ordinary consumers, the whole output being earmarked for work of national importance. Forge iron is now fairly plentiful, but foundry iron, on the other hand, is decidedly scarce. So much so, in fact, that certain brands can only be obtained under high priority. With the exception of some shipments to the Allies, export, meantime, is quite out of the count.

RAILWAY CONSTRUCTION IN ITALIAN SOMALILAND.—The *Gazzetta Ufficiale* of September 30 contains a Decree (No. 1,394), dated September 12, granting a loan of 18,000,000 lire for the construction of the Mogadiscio-Bur Hacaba-Baidoa section of the Somaliland Railway, from Mogadiscio to the Ethiopian frontier, and for the provision of the necessary rolling-stock. A copy of the Decree can be consulted at the Inquiry Room of the Department of Overseas Trade (Department and Intelligence).

PETTER'S SEMI-DIESEL OIL ENGINES: ERRATUM.—In our issue of last week, on page 466, there was an illustration of a single-cylinder semi-Diesel engine by Messrs. Petters, Limited, Yeovil, and on page 461 it was stated that this represented Messrs. Petter's latest type which was made in 35 brake horse-power and 50 brake horse-power sizes. This statement was inaccurate, since Messrs. Petters oil engines of this type are made in single-cylinder sizes from 10 brake horse-power to 75 brake horse-power, and up to 300 brake horse-power with multi-cylinders.

SWISS-RHINE NAVIGATION BOARD.—In connection with the carrying out of the harbour scheme the Governing Council of the Canton Basel-Stadt, says the *Kölnische Zeitung*, has entrusted the treatment of all questions concerning large shipping on the Rhine to an extraordinary Rhine Navigation Board. All navigation business passes therefore from the Department of the Interior and from the Finance Department to the new Board, while the necessary construction work will continue under the supervision of the Building Department. The Navigation Office of Basel-Stadt has been attached to the Rhine Navigation Department for immediate administrative work.

QUEENSLAND RAILWAY COMMISSION.—The report of the Royal Commission on Queensland Railways contains much of interest in relation to the development and improvement of railway facilities in that State. It says: "One factor which interferes with the economy of the construction of new railways, and of new work in connection with the existing railways, is having under way at one time construction at more points than the exigencies of the treasury will allow to be carried on in full swing. Our attention has been called in a number of instances to the work, some of very considerable importance, which on completion had been found to be unsuitable, in location or design. There seems to have been occasions when even the lowest type of workman on the job was able to perceive unsuitability, and notwithstanding this plans are carried out because they are plans. Placing the responsibility on every employee in charge of the job would we think have a salutary effect." Regarding the Ipswich workshops the report states that generally speaking the system of management, control and working of the workshops appeared to be well devised for efficient working and management. Regarding the construction of rolling-stock the Commission recommended that on lines of economical working, when any particular work had been commenced it should be completed without interruption, as all concerned worked with better result when allowed to proceed at full swing than when diverted from one-half finished job to another.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Tax-Free Investments.—A somewhat novel issue is announced by Messrs. Thomas Firth and Sons, the well-known armament firm of Sheffield, in the shape of 600,000*l*. 5 per cent. cumulative preference shares free of income-tax. In the majority of cases the payment of income-tax by a company on its dividends is a concession that may be discontinued at any time. The new shares being offered at par, this is equal to a yield of 7*l*. 2*s*. 10*d*. per cent. subject to a tax of 6*s*. in the £.

Iron and Steel.—Reconstruction bulks largely in Sheffield business circles this week. There seems a general opinion that war conditions will cease to operate in the early future, and the directorates of all the principal firms are closely considering the adaptation of businesses to the new era of peace. The question of labour is an urgent one. Skilled hands have been dispersed, and much machinery will be thrown idle when Government orders cease. The larger firms having machinery which they could adapt for munition work, have been able to keep together most of their hands, but the smaller houses have fared ill in this respect. The organisation of the labour supply will be a matter of the first importance. The general trade position in the city has not undergone much change during the week. The rolling mills are full of orders. The improvement in export facilities is benefiting the crucible and electric steel departments which for some time have been weak. Substantial orders have come to hand for overseas markets. Increased activity is observable in railway departments, spring makers being exceptionally busy. There continues a marked scarcity in both forge and foundry irons. The shortage in the latter is particularly pronounced, but in both, the tonnage available is considerably under the regular requirements. The large number of basic furnaces at work, on the other hand, are turning out a quantity of this material considerably in excess of consumption, and the authorities are criticised for having promoted too strenuously the make of basic at the expense of ordinary irons. Of finished iron there is a scarcity, notwithstanding the limited requirements from all but Government sources. This is not the case, however, in finished steel. Some sizes are monopolised by Government orders, but merchants are by no means left out in the cold. Scrap varies in demand. Wrought iron and cast-iron scrap are scarce, but other qualities are distinctly easier.

South Yorkshire Coal Trade.—The position of the coal trade shows no marked alteration, but little of the increased production is finding its way on to the market. Supplies of house fuel are very difficult to obtain. Prices are nominal and unchanged. In steam coal the demand is very active, both on home account and for export. Munition works are taking full supplies, and most of the collieries are considerably behind on contract deliveries. A similar state of affairs exists in gas fuels, works pressing for deliveries, and being thrown back on their reserve stocks through inadequate supplies. Slacks are scarce, with nothing in the open market. Blast-furnace coke is in strong demand at full maximum rates. Best branch handpicked, 27*s*. to 28*s*.; Barnsley best Silkstone, 27*s*. to 27*s*. 6*d*.; Derbyshire best brights, 25*s*. to 26*s*.; Derbyshire house coal, 22*s*. 6*d*. to 23*s*. 6*d*.; best large nuts, 22*s*. 6*d*. to 23*s*. 6*d*.; small nuts, 21*s*. 6*d*. to 22*s*. 6*d*.; Yorkshire hards, 22*s*. 6*d*. to 23*s*. 6*d*.; Derbyshire hards, 21*s*. 9*d*. to 22*s*. 9*d*.; best slacks, 18*s*. to 19*s*.; seconds, 16*s*. to 18*s*.; smalls, 13*s*. to 14*s*.

THE INSTITUTION OF CIVIL ENGINEERS.—The hundredth session of the Institution of Civil Engineers will be opened on Tuesday, November 5, at 5.30 p.m., when Sir John A. F. Aspinall, president, will deliver an address, and will present awards made by the council for papers read and discussed or otherwise dealt with during the past session.

TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has sent us a copy of a new series (No. 66) of additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this series can be obtained at a trifling cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

INDUSTRIAL COAL ECONOMY.—For this object, which is under the charge of the Technical Department of the Coal Control, the country is divided into areas and districts each with its engineer, whose function is to visit works, to consult with and advise the management how to secure efficient working so as to cut down the coal consumption. There are 400 engineers engaged in this work. In the United Kingdom there are between 40,000 and 50,000 steam users. Of these 6,800 cases have been reported for attention, and the process goes on at the rate of 1,400 a week. Improvements are being effected by the lagging of boilers and steam pipes, repair of defective brickwork in boiler flues, attention to leaky pistons and glands and the utilisation of exhaust steam for heating purposes, and of the hot flue gases for heating boiler feed water. A large aggregate saving is being realised by the employment of lower grade coal, thus releasing the better qualities for other purposes. The estimate of the Technical Department is that without any general installation of new plant, a saving of 5,000,000 tons of coal per annum is practicable, provided that the economy movement has general support and co-operation.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—So as to allow of larger shipments to the Allies, October allocations of Cleveland foundry iron to home customers were limited, but owing to the great scarcity of trucks, it has been found impossible to deliver the whole of the allotments, and once more cancellation of unfulfilled contracts is heavy. Urgent appeal is being made for more wagons. Very considerable quantities of iron are going by sea to Scotland, and with expected improved tonnage for this trade larger shipments to customers north of the Tweed are looked for in the very near future, and thus further relief to pressure on the railways is promised. November allocations are heavier than those of the past month, and as there is great pressure for supply, and iron is available, deliveries will be heavy if means of transit can be arranged. Forge iron continues quite plentiful and is selling on both early and forward account, contracts having been made as far ahead as January. Several makers, however, hesitate to commit themselves forward to any extent. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry and No. 4 forge are all quoted 95*s.*, and No. 1 is 99*s.*; whilst for shipment to France and Italy, No. 3 and the lower qualities are 122*s.* 9*d.* and No. 1 is 127*s.* 9*d.*

Hematite Iron.—Satisfactory account is given of the East Coast hematite department. With the much-increased use of basic iron and scrap for steel-making, the situation has been greatly relieved, and now no difficulty is experienced in meeting all essential home needs. Trade with the Allies is on quite a substantial scale, and with a good deal of tonnage coming steadily forward, loadings are heavy. Nos. 1, 2 and 3 hematite are 122*s.* 6*d.* for home use, and 147*s.* 6*d.* for shipment to France and Italy.

Manufactured Iron and Steel.—There is no relaxation in pressure for delivery of finished iron and steel. Works are very busily employed, shipbuilding material and constructional steel constituting the bulk of the output. Supplies manage to keep pace with demand. Prices, all round are very strong. The following are among the principal market quotations:—Common iron bars, 14*l.* 15*s.*; best bars, 15*l.* 15*s.*; double best bars, 16*l.* 15*s.*; triple best bars, 17*l.* 15*s.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 17*s.* 6*d.*; iron ship rivets, 21*l.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel strip, 17*l.* 10*s.*; steel hoops, 18*l.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*—all f.o.t. at works. Whilst export prices are not fixed, they may be given as approximately 40*s.* above home quotations.

Coke.—As regards coke the situation may be described as fairly satisfactory. Whilst there is still scarcity for some purposes, it is gratifying to have the assurance that needs of the local blast furnaces are being adequately dealt with. Average furnace coke is 33*s.* at the ovens, and low phosphorus quality 35*s.* 6*d.* at the ovens. A few sales of foundry coke to neutrals are passing, the price being 65*s.* f.o.b. Middlesbrough Docks.

ACTION OF REDUCING GASES ON HOT COPPER.—The mechanical strength of hot solid copper is much diminished when it is brought in contact with reducing gases. Copper straps initially ductile become friable and break when they are bent. The defect develops particularly in hydrogen, where it is marked at 400 deg. or 500 deg. C., but becomes very strong above 700 deg.; other gases weakening the copper are natural gas and carbon monoxide. It is assumed that the deterioration takes place particularly in copper containing disseminated cuprous oxide which the gas reduces to copper. That reduction would produce a void in the metal, since the oxide occupies more space than the metal itself; that, however, would hardly explain the great loss of strength. Investigating the problem in the Research Laboratory of the American Westinghouse Electric Company, Norman B. Pilling ("Journal of the Franklin Institute, September, 1918) started from the assumption that the reduction of the oxide by hydrogen would produce water vapour of considerable gas pressure; the vapour being less able to diffuse through the hot metal and less able to escape than the hydrogen would weaken the intercrystalline structure of the copper. Microscopic examination showed that the brittle copper had expanded during the treatment with hot gases. Pilling therefore studied the diffusion of those gases through hot copper by placing a thin-walled copper tube in a wider quartz tube, charged with the respective gas, evacuating the copper tube, and watching the increase in the gas pressure in the copper tube as the temperature of the tube was raised to 700 deg. C. Designating the rate of diffusion of hydrogen through the metal at 700 deg. C. by the figure 1,000, he found that the rate of diffusion of water vapour was 65, of carbon monoxide 17, and of carbon dioxide 0·6 only. In hydrogen marked diffusion already set in at 400 deg. C. The depth to which the reduction of cuprous oxide proceeded in solid pieces of copper agreed with the diffusion rate. Pilling also points out that the distribution of the cuprous oxide in the metal is very important. In wrought copper the distribution is uniform throughout the grains, whilst only those particles of oxide which happen to lie at the grain boundaries are operative in forming intercrystalline fractures. In cast copper the oxide is segregated as a eutectic of the grain boundaries, and this copper is very susceptible to hydrogenation. What one does not quite understand from the short account so far published is how carbon monoxide can have the weakening effect when the rate of diffusion is so very small compared to that of hydrogen.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—While there is a good deal of uncertainty as to the immediate future, the present situation on the local coal markets is decidedly more comfortable from many points of view than it has been for some time past. There is a good demand for large coals and these are being sent off steadily, and shipments have been very heavy during the last few days. Small coals, however, especially cargo sorts, are still weak, and stocks are very heavy. Production is maintained at a fair level, but the demand all round is great. The difficulty is in regard to transport, particularly in the case of inland requirements. The coalowners have had an interview with the Controller of Coal Mines on the matter, and this is stated to have been of a very satisfactory character, and it is understood that steps are being contemplated with a view to improving transport facilities, the lack of which has been hampering deliveries of through and small coals. General gratification is expressed that the Coal Controller's Department is less rigorous in the enforcement of the letter of control regulations than has been the case in the past, and it is anticipated that the larger measure of discretion allowed the District Coal and Coke Supplies Committee will be followed by less irregularity of working in the Western area, and a better distribution of inland business. There is now a strong inland demand for coke; collieries have been instructed by the Ministry of Munitions to accelerate deliveries, and permission has also been given for the export of a certain quantity of coke to France. It is understood that the Arrears Committee has now practically completed its work, and that it is submitting its report to the Controller. There was a flutter occasioned this week by the issue of the Controller's new directions. The main feature of these is the fixing of a higher minimum price for coals for neutrals, but the prices for Allied requirements remain unaltered. Inasmuch as practically all the South Wales outputs are taken up on official, Allied and home accounts there is little, if any left for neutrals, and consequently the new schedules are not of so much interest to these markets.

Newport.—The better class Monmouthshire coals are in active demand, and shipments have been heavy. There are good inquiries also for inland purposes, and especially for household qualities. It is now understood that the restrictions limiting supplies to districts Nos. 12 and 13 have been relaxed to such an extent as to permit deliveries to other districts when transport conditions admit of this being done. The result is that outputs are moving off more rapidly, and the general conditions are accordingly improved.

The Eight-Hours' Day Agitation.—Notwithstanding the personal intervention of the Coal Controller, and his assurance that there should be a curtailment of the hours of colliery surfacemen immediately after the cessation of hostilities, the miners' leaders have not been content with this assurance. After the interview which Sir Guy Calthrop had with them last Friday, the Executive Committee of the South Wales miners' decided, in effect, to take matters in their own hands. They resolved to convene a conference of miners' delegates and to recommend the conference to adopt a motion to give 14 days' notice to the owners that on and after November 18 the men concerned will not work longer than the men handling coal. This means, of course, that irrespective of any agreement being arrived at, the eight-hours day is to be established for all classes of workmen. Such a drastic and arbitrary method of securing their ends on the part of the men has aroused a good deal of comment, but owing to the present national emergency it is not likely that the owners will resort to any retaliatory measures, for such a procedure would only result in a general stoppage—an eventuality which must be obviated at all costs in these days.

DUTCH SHIPPING FIRM'S PROFITS.—The *Weser Zeitung* quotes from *In-en-Uitvoer* the following statistics as to the economic development of Dutch shipping firms during the war: The total capital of the more important firms has increased from 98,034,000 fl. in 1913 to 123,635,000 fl. Their liabilities have decreased from 30,586,000 fl. to 28,054,000 fl., while their reserve funds have increased from 28,405,000 fl. to 148,555,000 fl. The number of vessels, which before the war was 277, has increased, in spite of losses caused by the war, to 307. Their gross registered tonnage has increased from 908,386 tons to 1,089,668 tons.

UTILISATION OF COPPER AND STEEL SCRAP IN CANADA.—The copper scrap obtained during the machining of the copper driving bands of shells produced under the direction of the Imperial Munitions Board, Ottawa, is refined and cast into ingots. Up to the middle of August, 10,000 tons of copper had been thus reclaimed, representing a value of approximately 5,000,000 dols. Steel scrap is also being continuously recovered in large quantities, the present annual value of which is approximately 5,000,000 dols. A subsidiary organisation of the Imperial Munitions Board operates works at Toronto, which are believed to be the largest electric steel works in the world. Here the steel scrap accumulation collected from several hundreds of munition factories in Canada is converted by the electrical process into ingots and forgings. Operations commenced in July, 1917, and the present monthly capacity of the works is about 5,000 tons of shell steel. Up to May 31, 900,000 6-in. shell forgings had been produced in addition to 69,500 9·2-in. shell forgings.

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, November 1, at 7.30 p.m., at 39, Victoria-street, Westminster, S.W. 1, a paper will be read on "Engineering as Applied to Cinemas," by Mr. W. E. Dines.

BRITISH FOUNDRYMEN'S ASSOCIATION: LANCASHIRE BRANCH.—Saturday, November 2, at 4 p.m., in the College of Technology, Manchester, Lieutenant-Commander Jackson, of Sheffield, will give a paper (illustrated by lantern slides) on "Electric Welding of Castings."

SOCIETY OF ENGINEERS.—Monday, November 4, at 5.30 p.m., in the Apartments of the Geological Society, Burlington House, Piccadilly, W. A Special Lecture on "Obstacles to Post-War Trade," will be delivered by Sir Richard Cooper, Bart., M.P.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 5, at 5.30 p.m. Address by Sir John A. F. Aspinall, the president, and presentation of Medals awarded by the Council.

THE RONTGEN SOCIETY.—Tuesday, November 5, at 8.15 p.m., at the Royal Society of Arts. The Presidential Address (illustrated by lantern slides) will be delivered by Mr. G. B. Batten, M.D., C.M.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Wednesday, November 6, at the Royal Society of Arts, at 7.30 p.m., Lieut. W. E. Williams will describe failures of parts of motor vehicles which have occurred in service.

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, November 6, at 8 p.m., at the Royal Institution, Colquitt-street, the president, Professor J. Wemyss Anderson M.Eng.(L'pool), M.Inst.C.E., M.I.Mech.E., will deliver his inaugural Address.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, November 7, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. The tenth Kelvin Lecture, "The Dynamical Theory of Electric Engines," by Mr. L. B. Atkinson, Member. Presentation of premiums.

THE BIRMINGHAM METALLURGICAL SOCIETY AND THE BRITISH FOUNDRYMEN'S ASSOCIATION (BIRMINGHAM BRANCH).—Thursday, November 7, 1918, at 7 p.m., joint meeting at the Birmingham Chamber of Commerce, New Street. Lecture by Professor T. Turner, M.Sc., A.R.S.M., F.I.C., "Research in Malleable Cast Iron."

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 8, at 6.15 p.m. Lecture to be given on "Electric Welding for Shipbuilding Purposes," by Mr. W. S. Abell, M.Eng., M.N.E.C.Inst., Chief Ship Surveyor of Lloyd's Register.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN, NEWCASTLE BRANCH, TECHNICAL SECTION.—Friday, November 8, at 7.30 p.m., at the Connaught Hall, Newcastle-on-Tyne, a paper will be read by Mr. W. R. Needham, on "Graphical Methods of Determining Bending Moments and Deflection of Beams."

PERMANENT GERMAN SAMPLE EXHIBITION IN WARSAW.—It is the intention of the Central Office of German Chambers of Commerce, says the *Norddeutsche Allgemeine Zeitung*, to increase German exports to the occupied territories in the East, and more especially to make it easier after the war for German goods to compete with foreign products. To this end the Central Office has decided to institute in Warsaw a permanent exhibition of German wares.

BREAKING OF LIQUID SKINS.—When a drop of some liquid is placed on a plane glass plate, and a ball put in the liquid and made to roll on the plate, the liquid will be squeezed out in front of the ball in the direction of the motion and obliquely to it, and will be drawn in in the corresponding directions in its rear. When the velocity of motion exceeds a certain small value, the liquid skin breaks in the rear of the point of contact. The phenomenon is watched with the aid of a glass lens (instead of a ball) and of the Newton rings, and when the breaking occurs, a bright curved line is seen which, on increasing the speed of motion, assumes the shape of a crescent or series of crescents, and of a broad bright band. This was observed by the late August Toepler who is known by other optical studies and in connection with air pumps and the Toepler-Holtz electric influence machine. In the *Annalen der Physik*, of June, 1918, pages 337 to 370, his son Professor Max Toepler, of Dresden, describes measurements of the velocities and forces involved. He first tried to replace the rolling ball by the bob of a pendulum. As this would not answer he fixed two glass plates on the bed of a lathe, placed a plane-convex lens on each plate and mounted a frame of aluminium, and wood on the lenses; the frame was rocked by a pendulum so that each lens tilted to and fro in the drop of liquid put on its plate. Many liquids were experimented with, pure water, mineral waters evolving gas, salt solutions, alcohols, amylacetate, &c. Toepler observed the following values of the critical velocity breaking the skin of the liquid: water 1.1 cm. per second, sodium chloride solution 1.8, alcohol 0.4, chloroform 1.19, benzene 1.36, toluene 1.46, carbon bisulphide 2.50, glycerin 0.017 cm. per second. He also investigated the influence of gases and impurities in the liquid, of radius of curvature of the lens, load put on the lens, &c. It will be seen that the velocity was very small for viscous fluids like glycerin, and Teopler found that the product $v_r \cdot \eta$ is approximately of the constant value 0.00714; here v_r indicates the breaking velocity and η the coefficient of friction of the liquid in dyne-seconds per square cm. Some such relation must evidently prevail; but it does not appear that the method would be convenient for determining the internal friction of a liquid.

ELECTRIC TRACTION ON THE CENTRAL ARGENTINE RAILWAY: THE MOTOR BOGIE.

MESSRS. MERZ AND McLELLAN AND MESSRS. LIVESEY, SON, AND HENDERSON, LONDON, ENGINEERS.

(*For Description, see page 505.*)

Fig. 26.

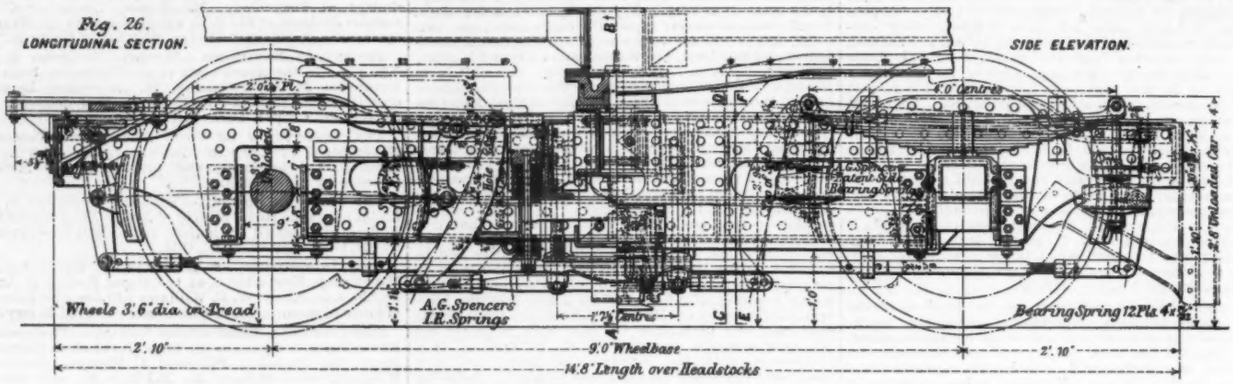


Fig. 27.

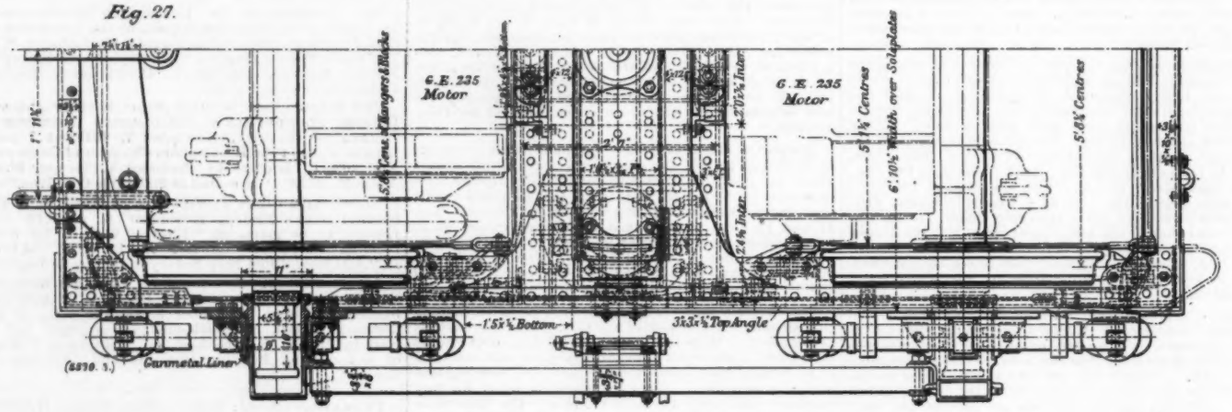


Fig. 28. SECTION A.B. SECTION C.D.

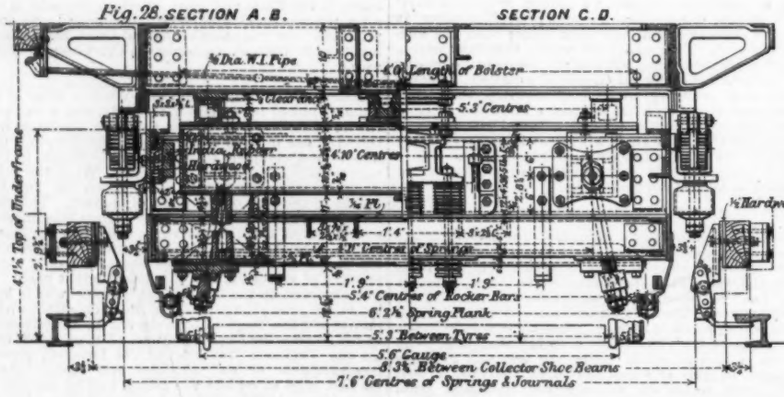


Fig. 30. END ELEVATION (OUTER END)

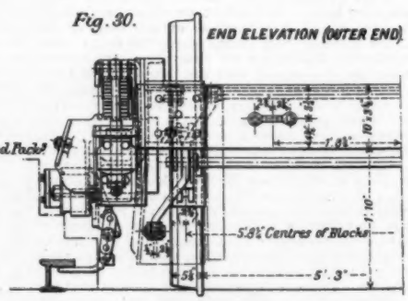


Fig. 29. SECTION E.F.

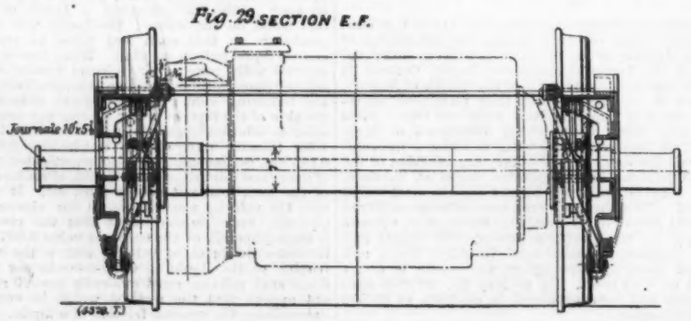
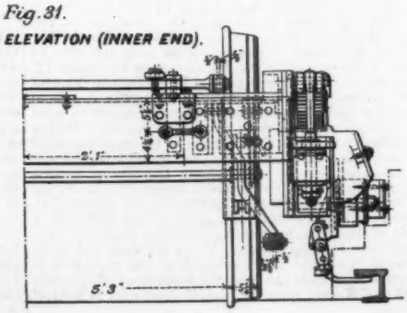


Fig. 31. END ELEVATION (INNER END).



ELECTRIC TRACTION ON THE CENTRAL ARGE[illegible]E R

MESSRS. MERZ AND McLELLAN AND MESSRS. LIVESEY, SON, AND HENDERSON, LONDON, ENGINEERS; T[illegible]OPOLITA

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Fig. 18.

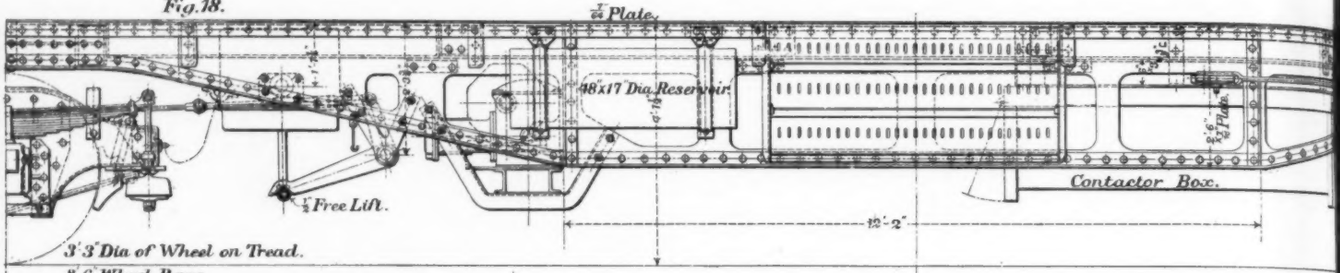


Fig. 19.

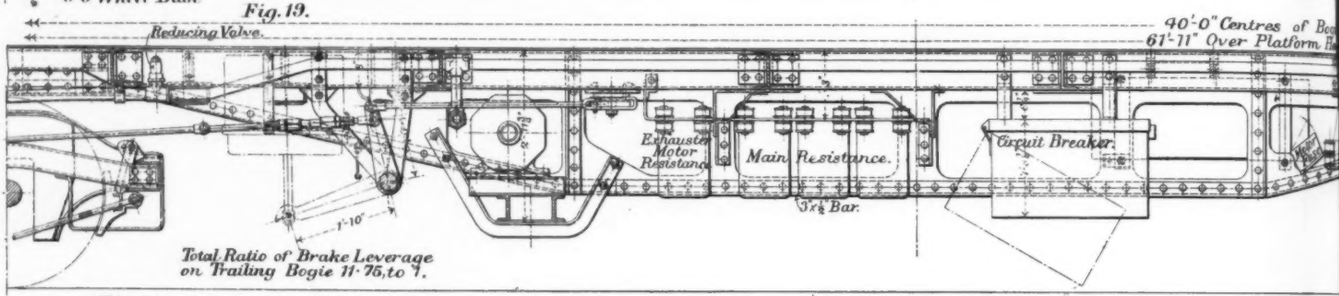


Fig. 20.

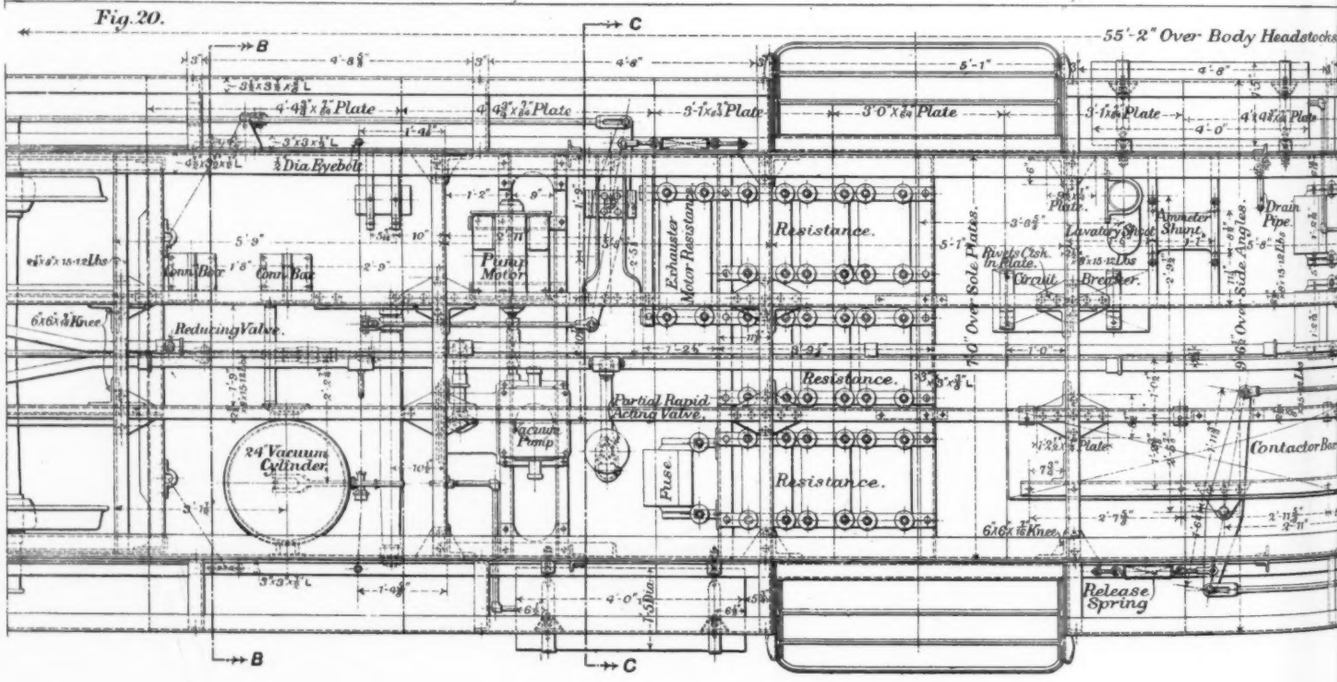


Fig. 21. SECTION ON CENTRE LINE OF TRAILING BOGIE.

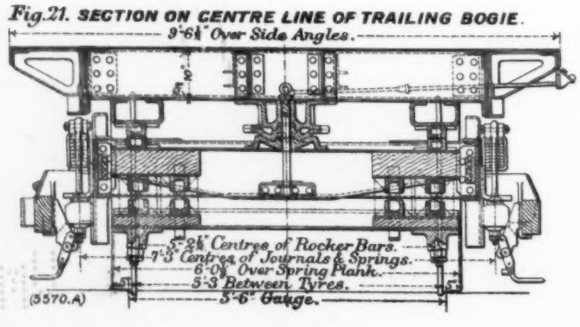
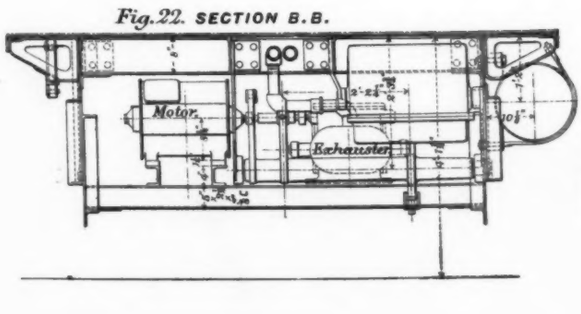


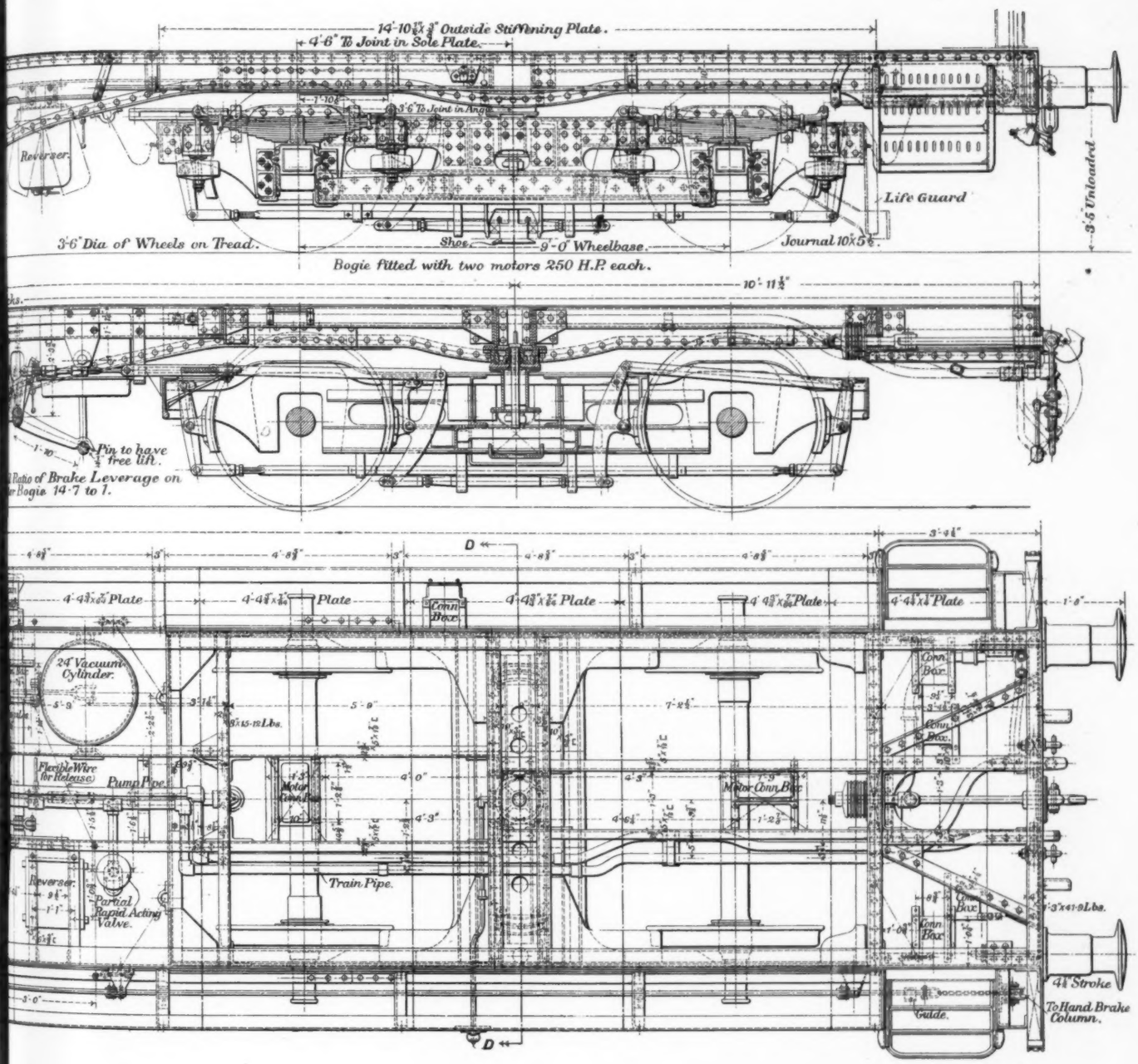
Fig. 22. SECTION B.B.



NE RAILWAY; UNDERFRAME OF MOTOR COACH.

POLITAN CARRIAGE, WAGON, AND FINANCE COMPANY, LIMITED, SALTLEY, BIRMINGHAM, CONTRACTORS.

Page 505.)



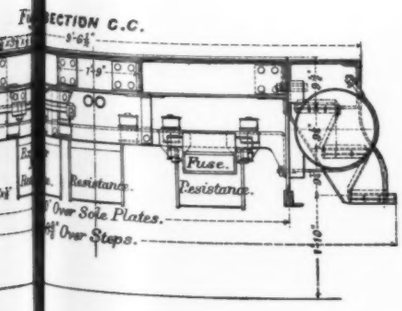


Fig. 24. SECTION D.D.

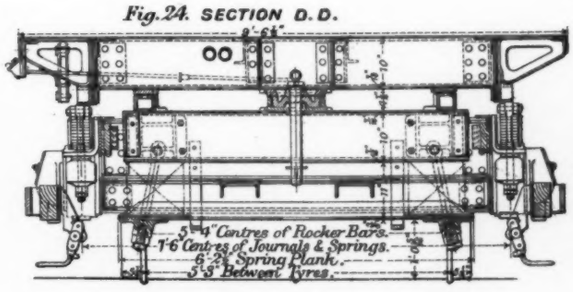
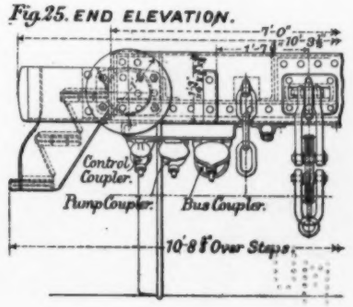


Fig. 25. END ELEVATION.



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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3063 and 8568 GERRARD.

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With a Two-Page Plate of the ELECTRIC TRACTION ON THE CENTRAL ARGENTINE RAILWAY: UNDERFRAME OF MOTOR COACH.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal further from 8d. to 9d. per copy. This increase dates from and includes the issue of Friday, March 1, 1918. The change will not apply to unexpired subscriptions. The revised rates for new subscriptions are given in the adjoining column.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers: therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 495.

ENGINEERING.

FRIDAY, NOVEMBER 1, 1918.

THE MERCHANT SHIPBUILDING PROBLEM.

We have repeatedly called attention in these columns to the vital necessity for the maximum output of merchant ships, both for present needs and for the re-establishment of trade at the earliest possible moment after the cessation of hostilities, but in view of the present position of affairs we make no apology for again calling attention to the necessities of the situation.

The bald facts of the situation at the present time are: (*a*) Great Britain as the largest shipowning and shipbuilding nation in the world has already lost about one-fifth of the total mercantile tonnage which it possessed in 1914, and (*b*) the rate of loss of tonnage still exceeds the rate of replacement, that is the rate of completion of new ships. (*c*) While the merchant tonnage of Great Britain is steadily decreasing that of foreign countries, notably America, Japan and the Scandinavian countries is steadily increasing.

All three factors are of the utmost importance to the Nation and to the Empire, not only at the present time but in the future, and the remedy for each is to be found in an accelerated output of tonnage from the yards and engine shops of this country. The control of all shipping in this country by the Government has naturally raised many questions of the greatest importance to shipowners, and while the future prospects from the shipowners' point of view may be charged with grave uncertainty, owing to the possibility of continued Governmental control, the main consideration at the present moment is the necessity for a largely increased output of tonnage and the immediate adoption of all means to that end.

Much has recently been written on the subject of the American shipbuilding effort, and, while the average shipbuilder in this country is apt to look with something akin to contempt upon the competition of foreign countries, it is only common sense to examine the achievements of these countries with a view to the adoption of any good points revealed. As regards the American effort the information available is too scanty to assess the relative merits of British and American shipbuilding from many most important points of view, but the broad fact of the enormous production of tonnage from the American yards, and the disappointing output of our own yards, stands out too prominently to be ignored.

The American achievement is in itself most remarkable and worthy the most serious consideration of our shipbuilders and engineers, for it must be remembered that the industry is, comparatively speaking, in its infancy, the huge plant involved having been very largely laid down and the army of operatives trained during the last three years. The outstanding points in connection with the American effort may be summarised thus: (*a*) Large size of plant operated; (*b*) fabrication very extensively adopted; (*c*) installation of power plant and transporting facilities of latest design and of ample quantity; (*d*) training of the required operatives in use of machine tools and shipyard methods; (*e*) staffing of yards, &c., with managers and foremen who are not practical shipbuilders; (*f*) enthusiasm of all ranks of workers in attaining maximum output.

Of these points, (*c*), (*d*), (*e*) and (*f*) are of especial interest to British builders, as divergence of practice is more marked in their application than in that of (*a*) and (*b*). The pneumatic hammer has been adopted almost exclusively for riveting, caulking and cutting, and the required numbers of operators have been selected—with special reference to their suitability for the work—and intensively trained in the use of these tools under working conditions. For training purposes special full-sized parts of ships have been provided in some of the schools, and it is found that a period of from four to six weeks' training is sufficient to enable the pupils to take their place in the yards as efficient workmen. A recent return showed that in this country only a very small proportion of the total number of shipyards were provided with pneumatic plant, and even in the cases where the plant was provided no serious effort was made to utilise it to the full. Since the appearance of this return greater effort has been made to introduce pneumatic tools, as reported in our issue last week, but even at the present time there are large numbers of pneumatic riveting hammers lying unused in our large shipyards, although it is well known that they are entirely suitable for the work in hand, require one man less per squad in operation and give a larger output than hand riveting under the same conditions. No serious effort has been made on any large scale to train workers in the use of these appliances and the blame for this state of affairs rests jointly upon employers and workers.

The fact that America has been able to staff her yards in the higher positions with men who in many cases lack the practical training which is here regarded as essential, and that these men should be capable of organising shipyard work to such a degree as to build and launch a vessel in less than four weeks, is a new conception to many of our shipbuilders. The actual time taken to build the vessels is evidence of thorough organisation and proves the capacity of the responsible officials. Unfortunately it is not permissible to give details of some of the performances of our own yards in the building of warships of various types, but it can be stated with truth that some very remarkable and creditable performances have been recorded. In practically all these cases, however, it is certain that the credit is due to perfected organisation and good planning on the part of the responsible officials, rather than to any extra output on the part of the workers. It is indeed very doubtful if the output per ironworker is now as high as it was in 1914—in cases where output per hour is directly measurable, *e.g.*, riveters, it has been proved that the output is on the average considerably lower than in 1914. This fact is very closely connected with the enthusiasm of the worker. Reliable reports from the American yards lay great stress on the keenness of the workers and on the efforts made to kindle and sustain this enthusiasm. It would be difficult to find many shipbuilders in this country who would commit themselves to the statement that the workers are doing their best in the shipyards to-day. Whatever may be the explanation of the slackness in the shipyards there is one fact which is apparent to all who come in contact with the workers, and that is that the average working man has not yet grasped the fact that the rapid output of ships is war work of the first importance and that it is of at least as great importance as the steady production of guns, shells, tanks, and other mechanical appliances having an obvious and direct bearing upon the successful prosecution of the war to a victorious end. Efforts to arouse the interest and to stimulate the sporting instincts of the workers toward competitive effort have been on a wholly inadequate scale and lacking in conviction and co-ordination. With so many yards building the same type of ship it is surely possible for the authorities to devise some workable scheme

for the recognition in a suitable manner of the best building performances and at the same time to carry on a vigorous educational campaign throughout the yards.

The demand for the release of skilled shipyard workers from the army has been loud and insistent, and the lack of these men is still given as the main cause of the low output of new tonnage. It is undoubtedly the case that a very large number of the best tradesmen were lost to the industry in the early days of the war and that it has been impossible to replace the men thus lost. In view of the largely increased output of tonnage now demanded it is, of course, easy to prove to the Ministry of National Service the urgent need for skilled men as well as for semi-skilled and unskilled workers, but pending the satisfactory adjustment of the competing claims of the shipyards and the Army, every effort must be made to extend the principle of dilution of labour. In the shipyard the principal shortage is in the riveting trade and, as America has conclusively proved that efficient riveters for much of the work can be trained in a few weeks, there does not seem to be any excuse for this shortage—particularly as the work could be taken up by men of a low military grade. It seems probable that the proportion of skilled to unskilled men in the yards of this country is much higher than in America, owing to the fact that the number of shipyard workers in America at the start of their war effort was small—about 20,000 in all—while the number at present employed in the yards is over 300,000.

Delay in the completion of ships is frequently caused by the difficulty in getting machinery when required. Here, again, the shortage of skilled workers is given as the reason for delay and the principle of dilution is not whole-heartedly adopted. Much delay has been caused by the system of minute subdivision of machinery contracts over a large number of firms, many of whom have little or no experience of or facilities for turning out this class of machinery. Less sub-contracting and a greater use of diluted labour would probably give more satisfactory results.

The appointment of expert shipbuilders as advisers to the Ministry of National Service and to the Priority Department of the Ministry of Munitions would be of service to the departments concerned no less than to the shipbuilders, as claims for skilled and other workers could be investigated and decided on the spot, while the results of experience of the working of schemes of dilution of labour could be interchanged between these experts and communicated by them to the shipyards and engine works direct.

One of the greatest stumbling blocks in the way of increased efficiency and more rapid output is the conservative attitude adopted by many shipbuilders in regard to methods, and the fact that yard practice is in nearly all cases dominated by the views of the purely practical man. While there is much to be said in favour of the practical knowledge gained by hard experience there is ample evidence that the best results, both in this country and in America, have been attained by the adoption of scientifically developed methods which do not conform to the standards of the practical man.

A broadly-conceived and vigorously prosecuted educational campaign in the shipyards, together with the development of a healthy spirit of rivalry and competition carried out by the shipbuilding authorities, the adoption of every mechanical aid to increased production associated with the training and maximum use of unskilled labour, and the adoption of more scientific methods within the works, and concentration upon one type of product, are the first essentials toward increased production, while the prompt settlement of all claims for additional labour by means of the experts suggested would ensure the placing of the available labour at its point of maximum utility and thereby aid production.

It cannot be too forcibly pointed out to all engaged in the production of ships that the impetus given to shipbuilding in foreign countries, owing to war conditions, has radically modified the former pre-eminence of Britain in the industry and created a situation which can only be retrieved by the utmost exertions of employers and employed.

THE OXIDATION OF AMMONIA.

When we described, in our issue of November 3, 1916, how ammonia was burned to nitric oxide, and directly utilised in the lead chambers of some sulphuric acid works at Stolberg, Rhenish Prussia, experiments on the catalytic oxidation of ammonia had hardly been started on technical lines in this country. At the recent British Scientific Products Exhibition, the Munition Inventions Department of the Ministry of Munitions demonstrated the process as actually worked in lead-chamber plants of moderate capacity, and the standardised converters of the Department for a capacity of 80 tons of nitric acid per day have only twice the size of the converters shown in operation at the Exhibition. That is very remarkable progress, for which the Research Department deserves full credit, and the particulars, which were given by Lieutenant J. R. Partington, M.Sc., and his assistants in lectures delivered at the Exhibition, are of considerable interest.

The essential part of the apparatus is the converter in which a mixture of ammonia and air is burned by being brought in contact with the catalyst, glowing platinum. The converter unit is an aluminium tube, about 4 ft. in height, weighing 32 lb. The tube widens out and comprises a lower bend, 2 in. internal diameter; a cone; a square part built up of three sections; an upper inverted cone; and an upper bend. The parts are joined by horizontal flanges; the flange below the upper cone holds the platinum gauze, of which two or more horizontal sheets are generally superposed. At the Exhibition the sheet dimensions were 2 in. by 3 in.; their size is decisive for the converter capacity, and the standard size is 4 in. by 6 in. The ammonia may be supplied as gas. In technical practice, however, purified ammonia liquor of 25 per cent. is used; it flows down a coke tower through which air is drawn. The mixture of air and ammonia in measured proportions is cooled to condense water vapour and filtered through coke or, better, glass wool, to remove all dust particles, chiefly also iron, which would poison the catalyst. The sheets consist of platinum wire, 0·0025 in. diameter, woven to a gauze of 80 mesh to the inch; they are mounted in an aluminium frame. The gauze is heated to initiate the reaction, either by a gas flame—which must be non-luminous, as any deposition of carbon on the fine wires would corrode the platinum—or by the electric current. Partington expresses the reaction by the formula: $4\ NH_3 + 5O_2 = 4NO + 6H_2O + 220$ cal. Heat, it is seen, is liberated by the reaction, and this heat will maintain the platinum at red glow when the rate of feed and the proportion of air and ammonia are properly adjusted. The conversion efficiency, *i.e.*, the yield of NO, depends on these conditions, and can be varied by varying the rate of feed, the temperature of the gas, and the number of platinum gauze sheets. With one gauze and a rate of feed sufficient to yield 0·25 ton of HNO_3 (nitric acid) per square foot of catalytic area per 24 hours an efficiency of 90 per cent. can be obtained; two gauzes would raise the output to 0·35 ton at the same efficiency, or to 1·5 tons at 85 per cent., and four gauzes would produce 2 tons at an efficiency of 85 per cent. The efficiency is lowered by a too rapid gas feed, because some ammonia escapes unoxidised, and the platinum is cooled too much, unless the mixture (or the air alone) is preheated to 350 deg. C. When the platinum gets too hot, on the other hand, nitrogen passes away as such and is lost. Moreover, N_2O_3 or N_2O_5 may be formed instead of NO, and Partington recommends working for N_2O_5 and keeping the catalyst at red glow between 650 deg. and 700 deg. C. An output of 1·5 tons of HNO_3 per square foot of catalytic area has regularly been attained with the high efficiency of 95 per cent.; without applying external heat the efficiency realised will be about 85 per cent.

Calculated on the weight of platinum used these efficiencies are very striking. The gauze weighs about 50 grammes per square foot, and with two superposed gauzes the output of nitric acid amounts to 15 kg. per gramme. The yield is, however, strongly dependent upon the purity of the materials. All catalysts are very sensitive to impurities, a point to which Mr. Partington did not particularly refer. Iron is one of the poisons; in the Stolberg plant the converters are made of iron, but are lined with aluminium. Acetylene is another dangerous poison; we alluded to this in our paragraph on the experiments by Taylor and Capps, of the United States Bureau of Mines (see Engineering, page 296 *ante*, September 13, 1918). Something might be said on other impurities to be guarded against. Properly treated the gauzes will serve three months, according to Partington; they are then replaced by new gauzes and cleaned and refitted. On the other hand, new gauzes are not at first active, but they acquire their full activity after a few hours' running.

The hot gases leaving the converter at temperatures of from 400 deg. to 600 deg. C. have to be cooled to 30 deg. and to be mixed with more air to pass into NO_2; the water vapour which is condensed at the same time should not carry down more than a small fraction of the oxidised nitrogen. The further utilisation of the NO_2 is the second difficult part of the problem which is not quite solved yet. Although the yield of a converter is frequently calculated on the HNO_3 obtainable, the actual conversion of the nitrogen oxides into nitric acid is not always carried out. We stated already that the NO and NO_2 may at once be sent into the lead chamber in order to oxidise the SO_2 to sulphuric acid, and that is actually done in several of our large sulphuric-acid works, which used to "pot" nitre with sulphuric acid in order to generate the nitrous gases required for this oxidation. Before the war some 18,000 tons of nitre were imported into England for this purpose. That nitre is now saved, and with the present dearth of nitre this achievement is particularly valuable. But nitric acid itself is wanted, and the absorption of the vapours by water, lime, caustic alkali, or ammonia itself to obtain nitric acid or nitrates, does not work very satisfactorily so far. We have referred to these difficulties on other occasions. There remains a good deal to be done in the synthetic nitrogen industry. Mr. Partington mentioned that the United States Government has allocated 20,000,000*l.* for the erection of five large nitric acid works. Ammonia oxidation plants are already in operation in the United States, and in France, Italy and Russia. Some of these works are national; this country does not possess any national synthetic nitrogen works.

TRADE WITH THE DOMINIONS.

The brightening prospects of the war are turning the thoughts of engineers to the time when the demand for all kinds of munitions will cease. All the overseas markets are depleted of goods, and an immense demand is ready to put itself forward as soon as there is the prospect of its being entertained and shipping can be found to undertake delivery of the goods. In the first months, and possibly years, manufacturers will be able to choose their customers as they will, but this state of affairs will not last for ever. It is most important that the choice should be made of markets that are likely to offer an enduring demand, and that care should be taken to supply goods which will be a credit to Britain. To assist manufacturers in the selecting of markets the Government has issued a series of reports from H.M. Trade Commissioners,* all of which will repay careful study, as will be seen by a number of extracts relating to the metal industries which we have prepared.

The first report, which is by Mr. W. G. Wickham, H.M. Trade Commissioner in South Africa, contains a large amount of information on the industry, agriculture and trade of the Union for the year 1917; much of this, although of great general interest, is outside the scope of our columns. Notwithstanding, our readers will be glad to note the following chief points which, according to the Commissioner, make the past year notable in respect of industry in the Union:—(1) The first census of industrial production. (2) The formation of a Federation of Industries in which are associated all the Provincial Manufacturers Associations and the affiliation of this Federation to the British Empire Producers' Association. (3) The formation of the Industrial Development Company, Ltd., to provide practical assistance in the form of funds for new industrial enterprise, this supplementing

* H.M. Stationery Office, Imperial House, Kingsway, W.C. 2. Price, 3*d.* each.

the investigation, supervision, and guidance provided by (4) the new thoroughly organised Industries Section of the Department of Mines and Industry with its advisory Council of Industry, Statistical Committee and Scientific Advisory Board. (5) The first publication of the official monthly *Journal of Industries*, and (6) the protection of companies to establish vitally important primary industries, notably the production of iron.

Dealing very briefly with the iron industry, the report states that it is by far the most important, but one of the chief difficulties in the way is the rarity of good coking coal. Coke, consequently, has hitherto been expensive, and the supply hardly adequate for the foundries. Very considerable improvements are understood to have been brought about recently. Two companies are erecting blast furnaces, the one at Pretoria and the other at Vereeniging.

The development of railways and harbours is slow as a result of the war. The railways have had to face a very difficult situation owing to the impossibility of getting locomotives, rails and many important items of material and stores. The enormous increase of the coal traffic necessitated by the demand for bunkers has materially increased the difficulty. The change relating to the coal industry consists of an agreement to group the output of the Natal coalfields by quality. Against a contract for a specified coal, any other coal in the same quality group can be tendered. Previously to this pool, a steamer might be held up waiting for a specific coal for which trucks could not be supplied owing to the congestion of trucks in Durban waiting for steamers which had not yet arrived. This difficulty has now been obviated; and while no doubt the new arrangement—on which the Mining companies and the Department of Railways and Harbours are to be congratulated—will produce the economy of trucks which was the primary consideration, there can equally be no doubt that it will also be found to be a great economy to the producing companies as reducing the wasteful expenditure on demurrage to a minimum and increasing the quantity of coal for which they can get transportation from their pits to the coast. While, therefore, this is strictly an economy forced on the companies from outside by the pressure of war necessities, it must be very doubtful whether, after the war, any case could possibly be made out for reversion to the old individualistic system.

Among the more important new industries which have recently been, or are on the point of being established in the Union, we may mention carborundum, calcium carbide, alcohol motor fuel, asbestos sheet and goods, the casting of shoes and dies for gold mine stamp batteries of steel from electric furnaces, sulphate of ammonia, tin smelting, the recovery of tin by detinning scrap, &c.

Apart from the above, a large amount of data is given in the report on gold mining, on exports and imports, agriculture and labour within the territories of the Union.

A recent report which we have also received deals with the trade of Canada and Newfoundland for the same year, 1917, by the Officer-in-Charge of H.M. Trade Commissioner's office at Montreal. From this we note that according to a preliminary estimate by the Department of Mines, the total value of the metal and mineral production of Canada in 1917 was 192,982,837 dols., compared with a value of 177,201,534 dols. in 1916, or an increase of 8·9 per cent., and compared with a value of 137,109,171 dols. in 1915, equivalent to an increase of 40·8 per cent. The tonnage output, however, in many important products was considerably less in 1917 than in 1916. Coal, gypsum, cement, gold, silver, copper and lead were all much lower as regards output; but there had been increases in the quantities mined of zinc, cobalt, molybdenite and nickel.

In Canada, war exigencies had prevented railway construction, which, in normal times is a necessary factor in the progress of development of the Dominions. Besides this, a considerable mileage of the rails on the lesser frequented sections of the various lines had been removed and shipped to France for the use of the Allies during the past year. In regard to shipbuilding, under the stress of important government orders, this was making advances on the East and West Coasts, at Montreal, Quebec, and other towns on the St. Lawrence, and on the Great Lakes.

The most important fact bearing upon the economic situation of Canada during 1917 was the entry of the United States into the war. The United States authorities have since found it imperative to curtail the export of much raw material which came freely into Canada. Meanwhile, Canada, is receiving immense orders both from the United Kingdom and from the United States for munitions and equipment needed for war purposes, and will have to rely mainly upon the United States to supply her with the raw material necessary for their manufacture. There still remain many industries concerned with the manufacture of articles of personal or household necessity, and for these Canada will be dependent more and more on her own resources while the war continues.

Statesmen and business leaders are now urging upon the manufacturers of Canada to look ahead and consider ways and means to organise for an intense production to meet, when the war ceases, the requirements of the home and export markets. It is impossible to say exactly what effect there will be on Canadian prosperity upon the cessation of the war, but Canadian manufacturers may be expected to bring all possible influence to bear for the increase of tariffs on goods which it is anticipated that Canada can produce. United Kingdom manufacturers, when the war ceases and labour is once more available for peaceful purposes, should have no fear, the report states, that they will not be able to regain the businesses they have been compelled to relinquish during the war, provided they maintain their system of supplying goods above reproach at reasonable prices. So far as the Canadian market is concerned, there will probably be large purchasing power available to absorb United Kingdom productions of a kind suitable for the country.

A further report, by Mr. G. T. Milne, H.M. Trade Commissioner in Australia, deals with the trade in the Commonwealth for 1917. This, like the two former ones, is very extensive, and covers all branches of activity.

Selecting a limited number only of the points dealt with, we find it stated that in no year since statistics regarding industrial strikes were first collected has there been so much unsettlement as in the year under review. There were 444 disputes during the year, involving 173,970 workpeople, the estimated loss in wages amounting to 2,641,735*l*., Mining and quarrying, manufacturing, shipping, wharf labour, railway and tramway services were the activities chiefly involved. Moreover, the restriction in the use of coal and power, rendered necessary for the conservation of the former, reacted seriously on industrial establishments and led to a great deal of unemployment. Several unions in New South Wales were de-registered under the War Precautions Act, and the "preference to unionists" clause was cancelled in some instances in Victoria.

The principal work in connection with the extensive programme on irrigation, foreshadowed in the Report on the Trade of Australia for 1914 relative to the development of the River Murray for irrigation and navigation, has been carried out in the State of South Australia, where the construction of a lock and weir at Blanchetown is in progress. In New South Wales and Victoria the only work done in the matter of irrigation has been in connection with the further investigation of sites for the proposed storage on the Upper Murray.

The Hydro-Electric Department of the Tasmanian Government continues to develop its undertaking, and in addition to supplying the Municipal Tramways at Hobart, as well as light and a certain amount of power to other users, power is being supplied to a company engaged in the extraction of metallic zinc from concentrates by the electrolytic process, as well as to a concern manufacturing carbide of calcium. Projected developments include the supply of power to a woollen mill, and to certain industries near Launceston. The demand for power appears to be in excess of the supply, owing to the difficulty experienced in getting delivery of the necessary plant. The Hydro-Electric Department has in view the development of further sources of power in the Island State, and one may safely predict, the report adds, that the activities of the Department will have a far-reaching effect on its future.

In Victoria the Government has been investigating the possibility of developing the immense deposits of brown coal situated at Morwell, and other places in this State, while a local group is endeavouring to obtain from the Government a lease of certain water powers. In the Report of the Advisory Committee appointed by the Victorian Government to investigate the possibilities of brown coal, it is stated that the power generated in the Metropolitan power houses in 1908 amounted to 14,000,000 units, and that by the year 1917 this total had grown to 72,000,000 units, the average increase per annum being 20 per cent. The same report says that, assuming this rate of increase to be maintained, and allowing for the conversion to electrical traction of the cable tramways in Melbourne, it is estimated that the requirements in the year 1921 will amount to 163,000,000 units, with a maximum demand for 46,580 kilowatts, and in the year 1925 to 341,500,000 units with a maximum demand of 97,500 kilowatts. The report referred to, which is on file at the Department of Overseas Trade (Development and Intelligence), London, should be studied by those interested in power problems in Australia.

The proved efficiency of motor transport, the Commissioner also states, may conceivably lead in the future to new conceptions of the functions and sphere of branch or spur lines of railways in thinly peopled districts. If the amounts expended on the construction of such lines, which in many instances, he adds, remain unproductive for years owing to the small traffic available, were spent in the construction of roads suitable for heavy motor traffic, which would act as feeders to the main lines of railway, considerable economies could be effected. There are, according to the Commissioner, many instances in Australia, as in other new countries, where the requirements of a district could initially be served by motors.

In no section of the Australian import trade has the situation created by the war made itself felt so much as in that of metals and machinery. In 1913, the value of the imports of metals unmanufactured, partly manufactured and manufactured were respectively 1,575,734*l*., 1,500,436*l*. and 11,781,510*l*., and of machinery 4,841,625*l*. The corresponding figures for 1916-17 were: 466,848*l*., 1,210,872*l*., 7,761,700*l*. and 3,322,838*l*. The greatest shrinkage took place in the "unmanufactured" group, which includes ores, clays and mineral earths, gold in dust and bar, as well as iron and steel and lead pig. The "partly manufactured" group consists chiefly of iron and steel, brass and copper in the form of bars, rods, angles, tees, &c. It should be noted, however, when comparing the above figures, that the great appreciation in value which has taken place during the war period makes any deductions from statistics dealing only with values of but little guidance. The report further adds that owing to the development of the local steel industry, the imports of ingots, blooms and billets have declined considerably. The limited trade in brass bars, rods and strips was formerly done principally with the United Kingdom, but Japan now supplies an appreciable quantity. In the case of copper bars, &c., the bulk of the trade is with the United Kingdom. In this connection, and dealing with metal goods, the Commissioner states that complaints are numerous as to the unsatisfactory character of many Japanese supplies, and to Japanese condition of trading generally. Importers express their readiness to revert to the United Kingdom as their source of supply when conditions permit, but, he adds, manufacturers at home should not rely too much on expression or assurances of this kind, as the Japanese manufacturers are well informed of the criticism of their products and are making efforts to meet it. For the present, indications are that owing to increasing difficulties in connection with shipping from Japan (freights in mid-April were 9*l*. per ton and an advance was fore-shadowed), and to the urgent demands of larger and more important markets than Australia, there may be a falling off in the imports from Japan, not only of metal goods but of other commodities as well.

With reference to machinery, that for agricultural

purposes is largely supplied by Canadian and American manufacturers, and also in an increasing degree by the local manufacturer. At the important agricultural shows held annually in various parts of the country, local, Canadian, and American manufacturers are well to the fore, and, while certain British firms are also to be found amongst the exhibitors, it cannot be said that they are as much in evidence as their competitors. At present, the difficulties in the way of doing business are manifold but, wherever possible, it is well, according to the report from which we quote, to have a stand so as to keep the firm's name before the public, even although it may not be practicable to book orders for prompt delivery.

There has been a marked decline in the import of steam plant generally, particularly in that of locomotives. The practice of the Commissioners in the various states is either to place orders for locomotives with one of the several firms of local builders, or to build them in their own shops. At present, boiler plates, wheels and axles, and many other items entering into the construction of locomotives are imported, but it seems likely that in a future not distant many of these parts will be made in Australia. There has also been a considerable falling off in the imports of gas and oil engines. Many of this class of engines, particularly of the smaller kerosene type used on farms, are manufactured in Australia, in some cases by quite small firms. As a result, the absence of standardisation is apparent. On the other hand, the market for electrical machinery and equipment of every kind is important and certain to grow rapidly. The winding engines and pumping plant on some of the mines are of local manufacture, while, at Broken Hill, jigs, concentrating tables embodying the features of well-known tables of overseas origin, and tube mills, formerly made by Krupp, of Essen, are all made locally.

The imports of machine tools amounted to 148,300*l.* in 1913 and to 175,339*l.* in 1916-17, an increase, presumably, in value only. During the latter year nearly half of the trade was with the United States, while the United Kingdom did, approximately, the same amount of trade as in the former year. The growth of Australian industries suggest that this trade will increase. Machine tools from the United Kingdom are admitted free of duty under the preferential tariff, while those from other sources are subject to a duty of 10 per cent *ad valorem*.

A further report covers the trade of the Dominions of New Zealand, also for the year 1917. This has been written by Mr. R. W. Dalton, H.M. Trade Commissioner at Wellington, and, like the three other reports briefly dealt with in the foregoing, it covers a very wide field. It is interesting in the first place to note a remark to the effect that since the war New Zealand has been extraordinarily prosperous, and that as a consequence the potential position of the Dominion as a trading country is much stronger than it has ever been. The progress made by important industries during the war has been rapid and the whole Dominion is looking forward to a vast development of the country in general when the war is over.

The trades of interest to our readers, in which effort on the part of manufacturers will be particularly necessary after the war, are those in motor cars and tyres, motor bicycles, agricultural machinery, dairy machinery, electrical machinery, glass and glass ware.

The total imports into New Zealand of metal manufactures, other than machinery, amounted in value in 1916 to 2,589,784*l.*, in which total the United Kingdom entered for 1,799,901*l.* The corresponding figures for 1917 were: total 1,654,523*l.* and United Kingdom 789,573*l.* This decrease in a trade of such importance is a matter for concern, but it is hardly to be wondered at in view of the great restrictions placed on the delivery of goods of this class from the United Kingdom during the past year. In many lines (chiefly bulk goods) hardware stores in New Zealand are now almost denuded of stock and are finding it impossible to get deliveries even for urgent requirements. They have been obliged to turn to the United States for goods which they would not think of buying from that country in normal times, and they are now finding great difficulty in getting deliveries even from there. The most important increases in the imports from the United States since 1914 have been in galvanised corrugated iron and steel (from 3,653*l.* to 30,477*l.*), tinned sheets (from 344*l.* to 23,962*l.*), iron wire—other than fencing wire and telegraph and telephone wire—(from 508*l.* to 9,054*l.*), plain zinc sheet (from 660*l.* to 10,168*l.*), wrought iron tubes and fittings (from 6,571*l.* to 15,186*l.*), and hardware, hollow-ware and ironmongery (from 66,339*l.* to 85,478*l.*). As far as galvanised corrugated sheets are concerned, it is not likely that the United States after the war will be able to hold the trade they have gained. American sheets have been imported to satisfy an extremely urgent demand which could not be met from home, and they are not considered very satisfactory. The same is true of tinned sheets, but probably to a somewhat less extent.

The report states that a large business is being built up in malleable iron fittings from the United States; these are much cheaper than the wrought fittings from Colonial manufacturers and they are found to be eminently suitable for some purposes. It is understood that fittings of this kind have not previously been made locally. A much increased business has also been done from the United States in enamelled ware, supplies of which have been scarce; these goods are more expensive than the German goods which were previously imported, and it is questionable whether in normal times they will compete with those of British make.

In 1916, New Zealand imported machinery from the United Kingdom to a value of 629,748*l.*, the value of the machinery imports from the United States being 366,187*l.* In 1917, the figures were: United Kingdom 381,742*l.* and United States 393,715*l.* The year 1917 was the first year in which the imports in this class from the United States have exceeded those from the United Kingdom. Since 1914 the share of the United States in the total trade in machinery has advanced from 24·6 per cent. to 41·2 per cent., while in the same time the share of the United Kingdom has declined from 59·0 per cent. to 39·9 per cent. According to the Commissioner it will probably be in the trades covered by this class that British manufacturers will be hardest put to it to recover lost ground. British firms in some cases have not attempted to make certain machines on a competitive basis, and in others the British agency systems and pioneering work are not as thoughtfully planned, or as energetically carried out, as they should be. After the war there will be a considerable opportunity in New Zealand for the sale of machinery and plant, in connection both with the development of industries, whether primary or secondary, and with the execution of public works which are admitted to be urgently necessary. It is not safe to imagine that because New Zealand is a British Dominion British trade must necessarily be safe. American firms have not only secured some of their most valuable trade since the war in British Dominions, but, apparently, they have also organised to do so. The Commissioner expresses the hope that firms and associations at home will realise this and will take steps to see that, as soon as the war is over, if not before, expert investigations are made and plans laid to go more energetically into this branch of trade in New Zealand.

The same note is struck by the other Commissioners in regard to business between the United Kingdom and their respective dominions. All are animated with the most earnest desire to foster industrial and commercial intercourse with business enterprises "at home." The latter should not fail to avail themselves from now of the facility offered to strenghten still further the bands which unite together the various territories forming the British Empire; they will, we feel confident, receive every guidance they may need to this end from the Comptroller-General of the Department of Overseas Trade (Development and Intelligence), who centralises all business transactions with the various Dominions and Commonwealths.

NOTE.

Development of the Department of Chemical Technology, South Kensington.

The Department of Chemical Technology, of the Imperial College of Science and Technology, is to undergo a very important development and extension in order to meet the requirements of the post-war situation on a scale commensurable with the responsibility of the college to the Empire. The Department is to be reorganised so as to include the following principal sections, all under the present head of the Department, Professor W. A. Bone, F.R.S. The A Section, Fuel Technology and the Chemistry of Gases with Refractory Materials, is to be located in the present Fuel Block of the college which it is proposed to enlarge by the addition of two further stories and to extend right up to the front of Prince Consort-road. Accommodation will then be gained for (*a*) general fuel technology and the study of the constitution of coal, peat, and lignite; importance is attached to the investigations on lignite already undertaken in the interests of the Dominions; (*b*) the carbonisation of coal and wood distillation, the scientific study of the latter being particularly desirable in the interests of India and some Dominions; (*c*) the chemistry of coal tar, ammonia and the manufacture of intermediate products from coal tar; (*d*) the chemistry of gases and technical gas catalysis with special reference to the new developments in the manufacture of ammonia, nitric acid, sulphuric anhydride, &c., resulting from the war; (*e*) refractory materials, clays, earths, sands used in furnace construction and the manufacture of cements, ceramics, and glass, including the materials for optical glass; (*f*) technical analysis connected with the foregoing. In Section B, Chemical Engineering, students are to be trained to work out, from their own notes and experimental work, commercial plant including the drawing up of plans and specifications and the organisation of factories; laboratories and drawing offices are required for the advanced study and investigations on (*a*) the materials, apparatus and principles involved in the design, construction and use of plant, in the transportation of solids, liquids, gases, in filtration, concentration, desiccation, crystallisation, cooling, cleaning, scrubbing, refining and in the application of high pressures and temperatures; (*b*) the design of foundations, flues, chimneys; (*c*) factory economics and organisation. Section C, Electrochemistry, is to be devoted to the study of the applications of electricity with special regard to the many processes depending upon the electrolytic or ionising action of the current; the war experience has emphasised the value of such processes to the country; electro-metallurgy is not especially mentioned in the outline of the present scheme. The selection of the subjects under Section D, Technology of Carbohydrates, Fats, Oils and Rubber, has been largely influenced by the consideration, that provision exists already in Manchester, Leeds and Huddersfield for the researches upon dyes and tinctorial chemistry, in Leeds and London for the study of the leather industries, and in Birmingham for the fermentation industries. The products chiefly to be studied are (*a*) celluloses, sugars, starches, gums, resins; (*b*) animal and vegetable oils and fats, glycerin, soap, food products (margarine, *e.g.*); (*c*) rubber and similar materials. As regards the extraction and refining of certain raw materials (chiefly of vegetable origin), the country does not possess adequate provision; stress is therefore laid upon the products mentioned, and upon the link which such investigations will establish with the Botany Department to the benefit of the development of the Empire's natural resources. One additional feature should not be overlooked. The Fuel Section had been able to arrange with the Skinningrove Iron Company for completing the training of fuel chemists in their works; similar arrangements are to be made with other works, and the college will be anxious throughout to keep in closest touch with industry. It is a very ambitious scheme, but apparently on sound lines. For buildings and equipment about 100,000*l.* will be required, it is estimated, for maintenance and working expenses, 10,000*l.* annually; if properly applied, however, this expenditure will be amply justified. We are particularly glad that Section B will pay attention to the mostly neglected general problems of cleaning, scrubbing, filtering, crystallising, &c. The ultimate success of the most promising processes depends practically upon the work of the chemical engineer.

THE INSTITUTION OF GAS ENGINEERS.

(*Concluded from page* 458.)

Gas Investigation Research Committee's Report (*continued*).

After the authors of the Report, Professors Smithells and Cobb, and Mr. Wood, had explained the nature of their investigations and the conditions under which they were made, as reported in our last issue, Sir Dugald Clerk rose to open the discussion. He pointed out the great importance of the work and said it covered the whole range of the use of gas, except for motive power. At present the average proportions in which gas was used was 35 per cent. for lighting, 35 per cent. for heating, and only 10 per cent. for power. It was obviously, therefore, very important to deal in the first place, and fully, with lighting and heating. As to gas for motive power, he might say that the original gas used in all gas engines was extremely satisfactory, with the low compressions which they used in the old days. If one were dealing with motive power, in the case of coal gas, the higher the calorific value the lower was the compression at which the engine could work. With the coal gas which was available before the war gas-engine builders usually adjusted their engines to a compression ratio of 5 or 5·5, and at that compression it was possible to get a very high efficiency, as much as 30 per cent. of the whole power of the gas. They also desired to try higher compressions, but they always found that, with coal gas, anything beyond 5·5 landed them in pre-ignition, and when it came to building large engines, say, of 3,000 h.p., they had to reduce the flame temperature within the cylinder, and so reduce the likelihood of pre-ignition. Speaking as one interested in gas engines, Sir Dugald said that so long as gas manufacturers gave them a certain number of heat units for their money they did not mind inerts—at least, so long as they did not have to pay for them. They could always get nitrogen and oxygen without paying for it. So far gas companies were quite at liberty to introduce carbonic acid into the gas for gas engines, because carbonic acid had what somebody called a poisoning effect on pre-ignition. He was very pleased indeed to hear that the calorific value of gas had come down. They did not want too much hydrogen, and they did not mind a little carbonic acid, as long as they were given a gas containing the requisite number of heat units.

When one came to the question of the incandescent burner, he thought Professor Cobb had rather erred in his definition of flame temperature. It was essential that they should have a gas capable of giving a high flame temperature. He would suggest that another test be applied to gas—not an official test, for of those there were already enough, but as a test for their own benefit—namely, to take a mixture of any gas with air, giving just the proper proportion of oxygen present in the gas and determine the maximum pressure of explosion by the electric spark. In that way one got a condition in which the flame temperature of that gas was tested if the gas was properly mixed. That was the flame temperature which really mattered. A gas must give the requisite flame temperature at the right place.

One great source of difficulty was that the pressure and the nature of the flame varied; then the same mantle did not fit the flame, and one had, as it were, the flame shrinking away from the mantle. One might have as high a flame temperature as one liked, but if the flame was not in contact with the mantle one did not get the light. He would like to impress upon Professor Cobb and the engineers of the gas industry that flame temperature defined in that way was really the essence of success in incandescent lighting. It was vital to have the capacity for flame temperature at the exact place where the incandescent matter must be ignited. He noticed that Professor Cobb gave the best result so far with the upright mantle as 13 candle-power per cubic foot. Of course, it was well known that it was possible to get 25 candle-power, and, if pressure were applied, even to get 40 candle-power or 60 candle-power per cubic foot. In considering the future, he believed that where the electricians made the best showing was in lighting, although one must remember, as against electric distribution of power, that even with the highest efficiency turbine one usually started with a loss of 80 per cent. of the heat in electric lighting. But although one had only a small efficiency of heat—20 per cent.—one got good results. Nevertheless gas had a better showing than even the best electrical results. Electricity generation showed a higher local efficiency, but the country was concerned with the amount of fuel dissipated at the source, and therefore in all these comparisons it was necessary to go back to the gas works for the efficiency of gas production and to the electricity station for the electrical efficiency; and on doing that it would be found that the incandescent mantle represented a very much better lighting efficiency from the national point of view of fuel consumed.

Sir Dugald was delighted to find that the efficiency of the ring burner was over 50 per cent. It said a great deal for gas boiling, and there again gas was superior to electricity. But, still, the attention had not been given which might have been given in the case of gas, to raising the efficiency in use. He would like to see a higher efficiency. It should be got up to at least 70 per cent. They should press it upon the manufacturers that they would not take an appliance unless it did give a higher efficiency. In considering the gas fire they must not confine themselves absolutely to radiation, because a good deal of heat came in by convection and conduction. About 50 per cent. was in the form of radiation, and even allowing for some loss at the back of the fire, one had about 15 per cent. more coming in from convection and conduction, and that meant 65 per cent. The 100 per cent. efficiency of the electrician ought to be closely examined; it depended on various conditions, as, for example, a draughtless room. There was a point in heating, however, at which electricity began to have an advantage. The maximum flame temperature of a 350 British thermal units gas was nearly 2,000 deg. C., and it was quite obvious that if they were going to heat up a mass of steel to about 1,500 deg. C. and had gas which would only give 2,000 deg. they had only 500 deg. difference at the top, and consequently were working inefficiently. The electric arc went up to 3,000 deg., a much higher efficiency. Still when one came back to the generator, the electric efficiency might mean only a 5 per cent. at the central station. It seemed to him that Professor Cobb and his colleagues were on very fruitful lines, and when further experiments were made he believed it would be found that with 400 British thermal units per cubic foot they could get suitable flame temperature on the mantle. It should be their aim to get the largest proportion of the heat of the fuel they carbonised into their pipes by distribution. At present the largest proportion they got in was 25 per cent., though a few somewhat uncertain tests showed it at 33 per cent.; they should aim at 50 per cent., and if they did that they must work at a thermal value of about 420 British thermal units.

Lord Moulton, after congratulating the authors of the report, said the committee had done right in taking one distinct part of the subject for consideration. But the behaviour of gas when burned was only one of the things they had to think of. There were two other clear domains of research which were equally important, and which had properly not been touched. The first was as to the best method of producing gas, the second the best method of selecting for combustion the components of gas. Coal-gas was composed of very many distinct chemical compounds, of which more and more were proved to have an industrial value far too great for them to be relegated merely to the domain of fuel. He saw indications that the loss was going to be seriously added to, and, what was more, the number of uses that well-known members of the group could be put to was increasing every day. The production of gas and the mode of selecting what they should use as fuel were the two broad domains of research which they must insist on being taken up by men of like perseverance and capacity to those who had made the report. When one gas was found to be inferior to another, while having the same number of thermal units, there was scope for invention so as to use it better. It was pointed out that, with regard to certain types of mantles, a rich gas would produce a better illumination than a poor gas, even though one burned a compensatingly larger amount of the poor gas; and yet, as Sir Dugald Clerk had pointed out, all that was wanted was the same heat units if one had the same flame temperature. The flame temperature on the mantle was clearly a thing which could be varied by devices which would make the flame not only fit the mantle at one pressure, but in a practical extent continue to fit it. That that had not been accomplished showed the weakness in the accepted methods of using gas. Wherever thermal units went to waste, gas engineers ought to feel it a reproach to themselves, for they should think, not only of the most efficient methods of producing gas, but also of the most efficient methods of applying it. It seemed to him that the positive results showed that they had a very large choice of types of gas, all of which would, for varying purposes, act equally well for the same number of thermal units.

Sir George Beilby said a very great step forward had been taken by the gas-makers since the meeting called by the Board of Trade, more than a year ago. The reporters of the Institution's Gas Investigation Research had asked them not to regard this as a record of completed work. For that reason alone it would be out of place to venture on criticism, and he could only express his full appreciation of the work that had been done.

After the luncheon interval, Mr. George Helps, of Nuneaton, the inventor of "Pleno" gas, continued the debate on the report. He asserted that he was getting at his works better results with 350 B.Th.U. gas than any other engineer was getting with 500 B.Th.U. gas. He alleged that the report was all wrong, and said that if gas engineers would not listen to him he would go direct to the consumers and lay the case before them.

Dr. E. W. Smith, chief chemist to the Birmingham Corporation Gas Department, said Mr. Helps had declined to give him information when he went to Nuneaton to investigate what was being done there, and he asserted that Mr. Helps had now walked out of the room when he (Dr. Smith) was invited to speak.

Dr. Davidson, of British Dyes, Huddersfield, Mr. W. M. Valon, of Stafford, Mr. H. Kendrick, of Stratford, also made some interesting remarks on the report; and were followed by Mr. W. A. Tookey, of London, who said he would echo the words of Sir Dugald Clerk as to gas-engine operations. The experience of internal-combustion engineers generally was that, as regarded calorific value per cubic foot of gas, there was very little in it. Engines had been worked with natural gas approaching 1,000 B.Th.U., as well as with blast-furnace gas containing about 100 B.Th.U. per cubic foot, and speaking in general terms, with small, as well as large engines, the same efficiencies were obtained within a very small variation. A point which was also interesting to internal-combustion engineers—and he hoped to gas engineers also—was that this held good equally when using petrol vapours and oil vapours (kerosene for example), of the heavier fuel oils. The number of B.Th.U. per h.p. hour was the absolute basis upon which the engine efficiency could be measured. That being so, did it not look from the gas-engine point of view, at all events, as if one B.Th.U. was as good as another. And it added point to what Lord Moulton had said, that if one B.Th.U. did not give the duty another B.Th.U. gave in an appliance, there must be something wrong with that appliance, and the matter should be considered as a subject matter for invention. If gas engineers were of opinion that a 500 B.Th.U. gas was essential, in order that the public should get the best efficiency out of the gas, the matter of appliances should be considered very seriously before they made up their minds. He thought it would be found that during the last few years there had not been so very much difference between the 500 B.Th.U. gas and the gas that was much lower. He was testing engines on the previous day using a gas which, by calometric observations, was only giving 420 B.Th.U. on a net basis, and he had tested engines also with gases of 368 B.Th.U. net, and they had done perfectly well.

In March, 1917, he was invited to give a paper before the Society of Chemical Industry, on the composition of power gases, and he epitomised in that paper some of the results which he had obtained as the result of a series of tests on gas engines he had been making for two of the largest London gas companies. Taking things one with another, and basing conclusions upon the number of B.Th.U. per cubic foot of piston displacement in the cylinder allowing for the clearance volume in the engine itself, one found that whatever the engine, whatever its date, whether made 35 years ago, or made to-day, the highest efficiency always had been obtained with a mixture strength of about 45 B.Th.U. per cubic feet of piston displacement. If one got, as he was confident one got, engines working so similarly for so many years, the same duties ought to be obtained from gas in other directions than power. It had been stated that a gas furnace could be just as efficient utilising 500 B.Th.U. as blue water gas, or even gases of lower calorific power.

He had been very much interested in Mr. Helps' process, because Mr. Helps seemed to base the same idea that he (Mr. Tookey) had had as the result of his experience with power. About six weeks ago he had an opportunity of going to Nuneaton, at Mr. Helps' invitation, to see what he was doing there. He would do nothing more now than attempt to tell what he saw—an upright incandescent mantle working on 500 B.Th.U. gas, side by side with one working with 350 B.Th.U. gas, and he could corroborate what Mr. Helps had said, that there was no perceptible difference in the illumination of those two mantles. He also saw a gas fire working, and saw the burners which had been mentioned by Mr. Valom, and saw some figures which carried a certain amount of weight. Being a sort of "doubting Thomas," he asked whether any complaints had been received from consumers, and he was not satisfied until he saw Mr. Helps' complaint book of the Nuneaton Gas Company. He scrutinised it very carefully, both before Mr. Helps began to issue the low-quality gas and afterwards, and the only complaints he saw recorded had nothing at all to do with gas engines; there were a few blocked-up burners, judging by the report of the man who had been round, but nothing at all which could be said to be the outcome of the lower-grade gas. To his mind, the 350 B.Th.U. gas should be equivalent in illuminating value, when worked with the mantles, to the higher grade; and as a sort of proof of that he saw also at Nuneaton an incandescent burner working with a gas which was ever so much below the 350, a gas which was below 200 B.Th.U. If that could be done—and it was done there—the case was not proved that a 500 B.Th.U. gas was the best that could be made. He thought it would be found on further investigation by the Research Committee that there would be some variation, and some very drastic verification would be forthcoming, particularly seeing that no deliberate attempt, so far as he could detect, in reading the Committee's report, was made to make any adjustments to the injector nipple of the particular burner used, whether of the old-fashioned or of the best type, without which adjustment it would be impossible to obtain the best results from the lower grade gas. As internal-combustion engineers had found that it was unwise to consider gas as the most important ingredient in the gas engine, he would advise gas engineers in all heating problems, such as illumination at the persent day and gas fires and gas furnaces, to look upon the problem as if air was the real heating medium, and that gas was the carburetting medium with which to bring up the air and make it better capable of transmitting its heat to the objects desired.

Mr. S. Tagg, of Preston, in his remarks, pointed out that the best efficiency was something over 53, compared with the lowest one of 39. That indicated very great room for improvement in regard to the design of cooking appliances. It was known that the manufacturers had the matter under consideration, and had carried out a great deal of experimental work, and probably when peace came it would be found they were prepared to put forward appliances which reached a very much higher degree of efficiency than those of the past.

Mr. Tun Duxbury, of Oldham, showed a photograph of two upright incandescent burners, one using gas of 691 B.Th.U., and the other gas of 497 B.Th.U. gross. With the former, the total B.Th.U. required was 3,098, and with the latter gas—2,839. The same pressure was carried in each case, and the illumination given by the 497 gas was equal to that given by the 691 gas. He scarcely thought that anyone could tell on examining the photograph, which gas was which. The two burners were bought in the town—Oldham—Bray burners, and they were regulated alike. The president and the secretary of the Cotton Spinners' Association, who were present when the two lights were burning, could not distinguish between the two. There were no smutty mantles, and no stopped-up-by-passes, simply because the 400 B.Th.U. gas could draw in naturally its proper quantity of air for the proper combustion of the gas. To boil a quart of water on a cooker hot-plate ring burner such as was used at Oldham, with gas of 593 B.Th.U. required 1,726 B.Th.U., whilst with the 441 B.Th.U. gas only 1,521 B.Th.U. were needed. He was perfectly convinced, after six months' working, that a 400 B.Th.U. was better gas than a 500 B.Th.U. gas.

Mr. S. B. Langlands, of Glasgow, Mr. Stephen Lacey, of London, formerly engineer to the Gas Light and Coke Company, Mr. C. S. Shapley, of Leeds, and Mr. Thomas Glover, of Norwich, having spoken, Lieut.-Col. S. Mitchells expressed, on behalf of the Committee, their very grateful thanks for the appreciative way in which their results had been discussed. He was sorry that, owing to another engagement, he had not been able to be present during the whole of the discussion, and, therefore, had missed Mr. Helps' speech. Some years ago he (Col. Smithells) had the honour of delivering a lecture to the Institution on the subject of flame temperature. He felt at that time that it was not so successful as he would have liked it to be, and he believed the reason was simply owing to the fact that the subject of flame temperature was an extraordinarily difficult and complicated one. Sir George Beilby's speech gave him great pleasure. The committee desired to work throughout in the closest possible harmony with the Fuel Research Board, and nothing could be so valuable and gratifying to the committee as to have such words pronounced on its first efforts, as were pronounced by Sir George Beilby. It was a matter for congratulation that in connection with so vital and important a question as fuel utilisation, there was at the head of affairs a man of such scientific eminence and such industrial experience as Sir George Beilby.

Unaccounted for Gas.

On Friday morning the first business taken was the report of the Life of Gas Meters Research Committee. It consisted of two communications: (*a*) "Unaccounted-for Gas," by Mr. B. R. Parkinson, and (*b*) "The Corrosion of Dry Meters," by Mr. J. G. Taplay, chief analyst to the Gas Light & Coke Company. We dealt with these papers on page 468 *ante*. Mr. Parkinson illustrated his paper by means of a number of lantern slides, and also gave a convincing demonstration of the apparatus for spraying meters with oil for renovating the leathers and valve mechanism.

Mr. Fred. Cockey, chairman of the Gas Meters Section of the Society of British Gas Industries, said that probably further inquiries would bring forth explanation of the cases where the increase or decrease of unaccounted-for gas did not correspond to the variation in the quantity of oil used. In one of the cases at least, the drop in unaccounted-for gas was attributable to the fact that a thorough and systematic overhauling of mains, services and meters had been undertaken about the time that the reduction took place. He trusted that the example of the Gas Light and Coke Company would be followed by other large undertakings which had the means of carrying out investigations on similar lines, but under their own special conditions. Mr. Parkinson's report, in as far as it dealt with corrections for pressure, temperature, &c., and leakage, appeared to point to the fact that losses through slow and non-registering meters formed by far the largest part of the unaccounted-for gas in the case of this particular undertaking, and from his experience during the last few years, and especially during the war, he was quite prepared to believe that this was generally the case. The deposit found on the valves was, in his opinion, alone sufficient to account for a very large proportion of this loss. The diagrams submitted by Mr. Parkinson, and the information given in Mr. Taplay's report, as to chemical actions, appeared to show that the presence of uncracked oil in suspension in the gas had not only a protecting but a cleansing and lubricating effect on the working parts of the meters. He would like, however, to have further evidence from other districts, as well as further information regarding concurrent conditions, as to sulphur compounds, ammonia, oxygen and CO_2 present in the gas before finally accepting the oil cure as a panacea for all the ailments of the dry meter.

If it was found after more extended experience that there were no injurious after-effects, and that the correct registration of meters could be materially prolonged by the introduction of a spray or mist, he thought it would be found that not only the cheapest, but the most effective way of using it, would be to introduce the oil into the gas at the works, or at different points on the district for a few hours at the period of maximum consumption daily, or at any rate at short regular intervals. The proportion of lost gas attributed to leakage in mains and services was so small that he thought it exceptional. From his own experience in country districts he was satisfied that the amount lost in this way would generally be more like 3 per cent.

Mr. R. E. Gibson, of Liverpool, said his experience went to confirm what the authors of the papers had stated. They had not had any great trouble at Liverpool, due to the deterioration of the meter leathers, and they had large numbers of dry meters of the pre-payment type. They had had some trouble, however, with regard to valves, and had noticed the presence of a gummy substance on the surface. Practically the whole of these ordinary meters were of the wet pattern, and they had been engaging their attention, in view of the high percentage of unaccounted-for gas. He had come to the conclusion that the leakage was largely due to the form of the meter they were using. The meters were tested at five-tenths pressure, and on going out were subjected at once to forty-tenths pressure, and being on the low-water line the meters, in consequence, registered against the gas company. They were now constructing meters which would not act in that way. In regard to wet meters, they had discovered an effect, which, while it was true that it did not affect the question of unaccounted-for gas, was still serious. The wet meter, when on the low-water line, was liable to close off the gas, and afterwards allow the gas to come on. That might have serious consequences, and, in his opinion, was a defect which absolutely condemned the wet meter as ordinarily supplied. They were now constructing a meter which did not suffer from this disadvantage.

Mr. A. E. Broadberry, of Tottenham, after complimenting Mr. Parkinson on his work, said that many of them had reduced the quantity of oil they had been using, and he fully expected that the experience at Tottenham would quite confirm Mr. Parkinson's conclusions. It was certainly a disappointment when he found that the year 1915 was very contrary at Tottenham. Subsequently, when Mr. Taplay started on to the other theory, and they supplied figures for Tottenham, he thought, as Mr. Parkinson pointed out, that they had found the solution. The increase in ammonia during 1915 was counteracting the good effect of the increase of oil; the increase in oil was not able entirely to stop the bad effects of the increase in ammonia. The investigations of Mr. Parkinson and Mr. Taplay had pointed out two very grievous causes of trouble with the registration of meters, and investigation followed up on these lines would help them very materially. The remedy of oil spraying they had already adopted at Tottenham, and they could quite confirm all the beneficial effects that Mr. Parkinson expected from it.

Mr. F. H. Robinson, of Harrogate, and Dr. R. Lessing, of London, followed with some remarks. The latter said that it particularly interested him

that Mr. Taplay should have established beyond any dispute that the leather substance was dissolved in liquid deposits in the meter, and also in various solutions of the compounds, which were generally found in the meter. Soon after the first report of the Life of Gas Meters Committee, a paper appeared, by Mr. Lamb, of the Leathersellers' Institute, who had worked on behalf of the South Metropolitan Gas Company, and in that paper a great point was made of the impossibility of dissolving leather in gas liquors. It was stated that any leather substances found in the liquors must be due to sprays of the nap of the diaphragm leathers. He (Dr. Lessing) was personally much obliged to Mr. Taplay for re-establishing his own previous analysis. At the time when he himself reported upon the reaction of carbon disulphide and ammonia, he hardly realised that the reaction upon which he looked only from the point of view of the deterioration of the meters themselves, could have such far-reaching influence upon what, to put it crudely, he would call the sale of gas.

He was not quite sure whether the effect of the oil gas on carburetted water gas was to send a spray of oil in any way similar to the spray that was used as a remedy in the meter. He did not know whether it had ever been stated before that this oil was carried forward in an oily form. He doubted whether, as a whole, the effect of the oil gas, as shown in the unaccounted-for gas, was of the same order as the effect of the spray put into the gas meter. He believed the differences were due to the composition of the gas. In carburetted water gas they had a gas entirely different from ordinary coal gas. He believed that great importance was to be attached to the composition of the gas, even to those components which were in very minute quantities. Amongst them there must be some which were particularly liable to be arrested in the meter. These compounds, apart from ammonia and carbon di-sulphide, were largely hydrocarbons. Was it not possible that such reactions were equally, if not more, responsible for the unaccounted-for gas? The repair shops of the gas companies extracted a very considerable amount of oily substances per annum from the meters, and this, if expressed in terms of gas (which it undoubtedly was before being deposited) would come to an appreciable figure in cubic feet. He would not like to do the calculation without data, but in the case of the Gas Light & Coke Company, if all the oil extracted from the meters was accounted for, they would have quite an appreciable proportion, he believed, of the unaccounted-for gas. This would be apart from the ammonia and carbon disulphide reaction, which also was responsible for the abstraction of some.

Mr. Taplay had found free sulphur in the complicated reaction of which he had spoken. Was it possible that any free sulphur found in the meter was actually obtained in the way he had described, or was it a question of oxide dust that was carried forward? Since writing his report in 1916, he (Dr. Lessing) had come across a number of instances of the most striking character of the transport of oxide from the works throughout the district. A very important gas company was faced, about eighteen months ago, with the apparent danger that their main system and service pipes were becoming altogether corroded by cyanogen. On looking into the question, he found that this was not the case, and he was able to establish it beyond doubt that the deposit which was accumulated in the mains, and right up to the meters was, in fact, fine oxide dust. By altering their purifiers and installing a special system for removing the dust, the company, greatly to its relief, eventually overcame the trouble.

Mr. Alexander Wilson and Mr. Ralph Halkett, both of Glasgow, followed with some observations. The latter said he had found advantage in the dressing of diaphragms by using a mixture containing a certain amount of black-lead instead of smearing them merely with olive oil. As to an unaccounted-for gas equivalent of 1 per cent. on mains and services, he must congratulate the Gas Light & Coke Company on the high efficiency they had attained in that respect.

The authors having replied to the discussion, the next business taken was the report of the Refractory Materials Research Committee.

Refractory Materials Research Committee Report.

This report consisted of a communication on "The Corrosive Action of Flue-Dust on Fire Bricks," by Mr. Walter Emery and Dr. A. Scott, of Stoke-on-Trent. The work described was carried out under the direction of Dr. J. W. Mellor, at the Central School of Science and Technology, Stoke-on-Trent, where most of the research work has been carried out.

The President said he had received a letter from Dr. Mellor, expressing his regret at being absent from the meeting, but he was engaged at Swansea at a meeting of the Ceramic Society, which, unfortunately, clashed with the meeting of the Institution.

Mr. J. P. Seaker (the acting hon. secretary and vice-chairman of the Research Committee), gave a resumé of the report, Capt. F. J. Bywater, R.E. the hon. secretary of the committee, who originated its valuable work by a paper read before the Institution in 1908, was kept away by his military duties in France. When at home, he is the engineer of the East Greenwich Works of the South Metropolitan Gas Company.

The proceedings of the meeting, successful in every particular, were brought to a close by a vote of thanks to the President, and to the Institution of Civil Engineers for the use of their premises.

The Empire's Mineral Resources.—The Imperial Institute has now issued a map with diagrams indicating the sources within the Empire of the chief metals of commercial importance. The map shows the occurrence in each British country of important metallic ores, and also the existence of deposits at present unworked. The diagrams attached to the map give for 1915 the production of each country as well as the total British output and the world's output of each important metal or ore. In the cases of manganese, chromium, tin and molybdenum the British proportion is near one-half the world's output. In regard to mercury and platinum we are almost entirely dependent on foreign countries for supplies. This publication should prove of great general interest, apart from its importance to those specially concerned in mining operations, and should be of considerable value for educational purposes. The map with diagrams has been placed on sale at the Institute, South Kensington, at a price of 5s. 6d., post free.

Requirements of British Columbia Timber Industry.—The Timber Commissioner for British Columbia in the United Kingdom has sent lists of lumber manufacturers and logging operators in British Columbia to the Department of Overseas Trade. These lists have been compiled from information collected in the early part of the present year, and they may be consulted at the Department of Overseas Trade (Development and Intelligence), or at the Offices of the Timber Commissioner, British Columbia House, 1 and 3, Regent-street, London, S.W. 1. The Timber Commissioner states that the value of the forest products manufactured in British Columbia in 1917 amounted to 48,300,469 dols., a value far greater than in any previous year. For 1918 a larger production and greater value than in 1917 is probable, judging by the returns to date. In considering supplies of machinery and equipment for the British Columbia timber industry, he adds, one must now include shipbuilding requirements, both for steel and wooden vessels. Shipbuilding is attaining large proportions in British Columbia, and should become a permanent and continuous industry. The main sources of supply at present are the United States of America and Eastern Canada—by far the larger portion coming from the States. Considerable quantities of wire rope come from the United Kingdom. The saw-mill industry is, for the most part, located in three regions: Vancouver and vicinity, Victoria, and Prince Rupert. There are mills of considerable size at such points as Alberni on the West Coast of Vancouver Island, Chemainus on the East Coast, and others at strategic points on the mainland between Vancouver and Prince Rupert, and on the Queen Charlotte Islands. Logging is general throughout the coast districts, with 50 per cent. of the production within 200 miles of Vancouver. The Timber Commissioner suggests that groups of non-competitive British manufacturers of machinery and equipment for the timber industry might be well advised to pool their representation on the Pacific Coast of British Columbia. British manufacturers will need carefully to study the special requirements of the timber industry of British Columbia, for the reason that in many lines logging and saw-mill operations on the Pacific slope differ from those obtaining in other timber-producing regions. The difference is largely one of size in the material to be manufactured and in the system of logging, which on the coast is practically all by overhead cable work. If the export trade in timber expands, he considers the industry will certainly require much additional equipment of a permanent character, and a continuity of trade in many lines of machinery, saws, and so forth should be assured.

THE SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the 1918–19 session of this society was held on Wednesday, October 23, in the University, Sheffield. Dr. M. W. Travers, F.R.S., presided over a well-attended gathering, and in his opening remarks referred to the great loss the glass industry has suffered in the death of Mr. A. S. Eaglemont, C.B.E., Controller of Optical Munitions and Glassware Supply. He paid a tribute to the great work of Mr. Eaglemont in stimulating the industry, and the society unanimously resolved to forward an expression of sympathy to the family of Mr. Eaglemont, together with an appreciation of his great services.

A report of the activities of the society since the June meeting was given by Dr. Turner, the outstanding feature being the institution of a Refractories Research and Specifications Committee charged with the drawing up of specifications for the various refractory materials used in the glass industry, and with the promotion of research upon the same subject. The Council of the Society appeals for the co-operation of every member in assisting the Refractories Committee in its arduous labours. To stimulate interest, the council had decided to devote the first meeting of the session to a discussion on refractories.

The first paper, entitled "*Refractory Materials and the Glass Industry*," was read by Professor J. W. Cobb, B.Sc., F.I.C. He emphasised the fact that although temperatures in glass manufacture were by no means abnormally high, yet the nature of the chemical reactions taking place was such as to render the problem of refractories extremely difficult. There was the corrosive action of the molten glass upon the container to contend with and, in addition, the corrosive action of hot dust upon flues and furnace interiors. The nature of the various refractory materials used in the glass industry was then dealt with; and the effect of grain size on the refractoriness and strength of silica bricks received thorough treatment. Special emphasis was laid upon the necessity for the smallest joints in building up of refractory materials, and furnace building should be regarded rather from the standpoint of masonry than of bricklaying. The paper closed with a discussion of the evil effects on refractories of penetration of glass and batch materials, and the importance of thermo-ductivity.

Dr. M. W. Travers, D.Sc., F.R.S., then contributed a "*Note on the Firing of Glass Pots.*" By means of a striking collection of specimens, the author showed that the life of a glass pot was materially increased if, before filling in, the pot was completely "vitrified." Ways and means of carrying this out were given and the reasons why vitrification before filling gave such good results were fully discussed.

A third paper on "*The Requirements of Clay for Glass Pot Making*" was contributed by Mr. S. N. Jenkinson. A brief survey was made of the position of the glass refractories trade both in 1914 and at the present time, and the necessity for some specification of materials was shown to be urgent. The proposed specification drawn up by the Refractories Committee for clay for pots was then dealt with, and its various sections discussed. The question of size, nature, quality and function of "grog" received full treatment.

Mr. Good–Pryor read a short note on the "*Action of Certain Types of Glass upon Pots*," and discussed the reason for the quicker solution of the bottom of glass pots as opposed to the sides. Several interesting experiments were described dealing with this problem. Dr. Turner and Mr. J. M. Davidson contributed a short note on "*The Solubility of Pot Material in Glass*," and showed the influence of grain size upon rate of melting.

A full discussion followed the reading of the papers, in which Professor Fearnsides, Mr. Hartley, Mr. Connolly, Mr. Teisen, Mr. Rees, Dr. Searle and the authors of the papers took part. The November meeting of the society will be held in Leeds.

New Shipyard at Catania, Sicily.—The British Vice-Consul at Catania reports that a shipyard is being constructed in the port of Catania, the enterprise being a private one under the style of "Cantieri Biriaco." The shipyard will be fitted up with two slips for the construction of cargo boats of 7,000 tons (deadweight) each, and with a ship-repairing dock capable of berthing vessels of about 1,500 tons.

Electric Calculator.—A calculating device has been prepared by Mr. G. Ellison's firm, Perry Bar, Birmingham, of which a sample has been submitted to us, to enable the ampères required for an electric motor to be quickly indicated where the voltage and horse-power are known. Four arcs are printed on a squared paper table, the arcs representing direct current and one, two and three-phase alternating current. Each arc is graduated in readings from 100 volts to 600 volts. The horse-power readings are in vertical lines on the paper and the ampère readings in horizontal lines. A straight edge is pivoted at the lower left hand corner and may be moved over the table. The straight-edge is set to the voltage scale; the horse-power line is then found at the place where it touches the straight-edge and crosses the ampère line, and this line gives the ampères required. For example: Let the supply be three-phase current at 300 volts and the motor 40 h.p., then the ampères required will be 73. An additional scale indicates that the cable required for connecting the motor to the power circuit is, in this instance, 19/16 standard V.I.R., S.W.G., I.E.E. Rating. The device is slightly over the size of the Engineering page and made of stiff millboard, with washable gelatine face and clear celluloid straight-edge. It will be decidedly useful to engineers and contractors.

INDUSTRIAL NOTES.

Speaking last Friday at the twenty-seventh annual meeting of Messrs. Furness, Withy and Co., Limited, the Right Hon. Viscount Furness gave the following information on the new shipyard built by the company on the River Tees :—

"In order to make good the serious losses to national shipping in general caused by enemy submarines, and also to meet foreign competition, it will be necessary to keep our lines supplied with ample tonnage of larger and faster design than has been utilised in the past; and with this object in view, we have, during the year, acquired a large and well-situated piece of land for the construction of a new shipyard on the River Tees, and we are proceeding with the utmost despatch to adapt and equip this site to become one of the most up-to-date shipbuilding yards in the country, it being particularly adapted for the rapid construction of large and fast vessels up to 650 ft. in length. Eight months ago, this site—extending to about 90 acres in area—was a waste piece of ground, situated some 12 ft. to 15 ft. below the high-water level. Within 2½ months the keels of the first two steamers were laid, and to-day we have seven building berths in operation. In addition, the construction of a fitting-out basin, capable of accommodating six large vessels, is making rapid progress. For the present, only fabricated ships of standard type are being built, the material being prepared at the various bridge works, and conveyed to the yard ready for erection. It was confidently expected that the first fabricated ship would have been launched next month, but, of course, whilst the preparation and construction of the shipyard is under our own control, the delivery of the fabricated material is not, and the anticipated date of launching will be delayed on this account. I might also add that we have sufficient land available on this site for the erection of engine works, should we decide, when hostilities are over, to build our own engines."

In the course of the same address, Viscount Furness gave a word of appreciation in regard to the magnificent service rendered throughout the war by the members of the mercantile marine, whose great courage and devotion to duty were only comparable to the bravery of our men in the field. All, honour, he added, was due to the masters, officers and men, but for whose pluck and dogged determination it would not, in his opinion, have been possible to prosecute the war to its present successful stage. They had well lived up to the ancient traditions of our merchant service.

Mr. E. W. Petter delivered at Yeovil last week the first of two lectures on "Industrial Reconstruction." After dealing with the war, he stated that it was difficult to draw the line between the producer and the non-producer. He claimed that everyone engaged in industry, from the employer to the humblest worker, was a producer. State control of industry, Mr. Petter added, meant substituting a red-tape officialism for private enterprise, and the experience of the State control during the war had satisfied him for ever that it was impossible to carry on industry under such conditions. He did not find that the interests of capital and labour were absolutely identical, but added that there was no inherent difference in the interests of the two. Capital and labour were interdependent. British industry needed a firm foundation and that foundation was production; limitation of production was national suicide. A factor contributing to the restriction of output were the long working hours customary in this country. A man ought to be able to earn sufficient to keep himself and his family in comfort by a working day of eight hours, and he ought not to be allowed to work continuous overtime. He, the speaker, would lay down the principle of the minimum wage, and men and women of less than average ability should be able, by faithful work, to ensure a reasonable remuneration. At the same time, success should be the goal held out to the competent, irrespective of the accident of birth. He had no faith, he repeated, in the State control of industry, but he had abundant faith in the State care of industry. He, also, was more and more convinced that there was no hope for the industry of this country unless it adopted the policy of Protection.

The annual meeting of the shareholders of the Port of Manchester Warehouses, Limited, was held last Friday, when the chairman, Mr. Marshall Stevens, stated that whilst satisfying the requirements of the Port of Manchester, the company had given, and was giving, a very valuable war-time service by preventing congestion, not only at Manchester, but at the other principal British ports, and upon the main line railways; and when this public service was being considered—although it was never likely to be appreciated at anything like its full value—it should be remembered that this now largest and best-equipped warehousing plant in the United Kingdom had been provided without the assistance of the Government being sought for a single penny of capital. It was, moreover, remarkable that the company had been able to continue building ahead of every emergency traffic requirement; for the management had never yet declined to store any traffic which—had they declined—would have caused congestion at any port or upon the railways. The company's facilities—although away from the quay side, so that they never interfered with the rapid loading and discharging of the ship—were within the dock area, and receipts and deliveries of traffic were exchanged over the five great railway systems of the country serving Trafford Park, entirely independent of dock work.

Peace was not yet near enough to give the interesting particulars of the vast volume of traffic which was dealt with by the company; but the average normal work in the warehouses exceeded 1,500 tons per day—it frequently exceeded 2,000 tons—and more than 6,000,000 packages of traffic had been handled during the year in the warehouses, the aggregate capacity of which was at least a dozen times as great as that of St. Anne's-square, reckoned from ground level to the height of the new exchange building. This was in addition to the 20 acres of land which was now fully utilised for traffic stored in the open.

With reference to the tin mines in Cornwall, the Committee on Production point out in their award issued last week, that both employers and the unions were in agreement as to the position of the tin mines being such as to call for the special consideration and action of the Government, and they endorse the views expressed before them by both sides as to the importance of the Cornish tin-mining industry and the urgent need which exists for a State inquiry as to the best means of ensuring the continuance and subsequent improvement of the industry. In particular, the committee state that they consider that the stoppage of what is called "development work" appears to them to be a feature of serious moment.

The award of the committee provides, in the case of most of the grades of workers concerned, for an advance of 10 per cent. on existing wages and for various alterations in the present conditions of service. The committee state that the award issued by them is intended to be an interim finding on the claims of the workpeople, in which they have, as far as possible, taken account of the various special factors which affect the claim submitted to them, and that it is to be understood that the award is open to review should the circumstances alter.

The Shipping Controller has had under consideration the remuneration of merchant seamen in relation to the special character of their employment and the extent to which the risks attendant upon their calling have been increased by the concentration of the enemy's submarine effort against the mercantile marine. He has also considered the rise to date in the cost of living and other factors. After giving full weight to the views expressed by the shipowners', officers' and men's representatives on the National Maritime Board, and after consultation with the chairman of the National Maritime Board, Sir Leo Chiozza Money, M.P., he has decided that, subject to the proviso that they are not to apply to seamen in vessels permanently trading outside the war zone or not subject to war risk, the following war risk bonuses are to be paid as flat rate additions to the standard rates of pay of all ranks of officers and seamen as already fixed on the recommendation of the National Maritime Board :—

War Risk Bonuses.—(1) For vessels on weekly articles, 10*s.* per week; (2) for vessels on monthly articles, 3*l.* per month.

The bonuses take effect for all navigating officers, engineer officers and petty officers and men of the deck, engine-room and catering departments as from October 7, including those whose articles were current at that date. These rates also apply to sailing vessels. Apprentices, ordinary seamen, first-voyage trimmers, deck boys and boys in the catering department, will be entitled only to one-half the above war risk bonuses. There will be no change in the overtime rates as the result of these increases, nor in the agreed food valuation of 21*s.* per week for men and 25*s.* per week for officers.

The following are some recent decisions given by the Committee on Production on cases which have been referred to them by the Ministry of Labour :—

Dockers, Great Britain.—From Monday, October 21, dock labourers receive a further advance, bringing the total war advances to 8½*d.* per hour in the case of men already in receipt of an advance of 7*d.*; in the case of men whose total advances are less than 7*d.*, a further war advance of 1½*d.* an hour is to be paid. The men concerned employed at the Port of Liverpool and paid according to the "White Book" rates of May, 1914, are to receive an increase of 1*s.* all round on present-day rates, night rates and Sunday rates; hourly rates to be increased accordingly.

Shipbuilding and Ship-repairing.—Drillers and hole cutters in all federated areas employed on lieu rates (which have not undergone any advance during the war except the general wages advances granted by the Committee on Production) receive an advance of 20 per cent. from first pay after September 13, except in cases in which the lieu rate is based on average piecework earnings which include this 20 per cent. advance granted to piece-workers under previous awards.

Dr. Macnamara, Financial Secretary to the Admiralty, stated in Parliament last Wednesday, in reply to questions, that the number of men released from the Colours for work in the shipyards was 15,370; in view of the urgent call for man-power in the Army, it had not been found possible to release men in excess of this number.

He also stated that the Admiralty had certainly not decided that shipbuilding was not now of the first importance; neither had they decided that the building of 3,000,000 tons per annum was no longer essential to the maintenance of our national strength.

The merchant ships under repair in the United Kingdom, either in dry dock or afloat, at October 17, were: British, 264, tons 979,161; Allied 31, tons 92,713; neutral 44, tons 77,955. Total, 339 ships and 1,149,829 tons.

We deal with shipbuilding in a leader in the present issue.

Weser–Main–Danube Canal Scheme.—According to *Wirtschaftszeitung der Z.*, a full meeting of the Werra Canal Union, whose chief object is the construction of a waterway for large ships between the Weser, Main, and Danube, resolved to submit the preliminary plans to the Prussian and Bavarian Governments. Progress has been made with the negotiations. The Board was authorised to undertake for this purpose pecuniary obligations to the extent of 400,000 marks. A proposal to include a branch line *via* Cassel was unanimously adopted.

Mixedstone Ferro-Concrete Posts for Electric Lines.—The Société Mixedstone, of Geneva, erects concrete posts for telegraph and power-transmission lines after the manner of brick pillars. The concrete bricks are supplied ready made in a thickness of 20 cm. to 30 cm. (9 in. or more); each brick is a frame, rectangular or of other shape; the internal hollow is charged with the cement, in which the iron rods are embedded. Four such bricks are, *e.g.*, arranged in each layer to make up a four-sided pillar which is built up in sections hollow inside. A telegraph post of this kind, of bricks 25 cm. thick, 25 cm. by 25 cm. at the base, and 20 cm. by 20 cm. in the upper sections, armed with four iron rods, 12 mm. in thickness, one in each brick, was tested last May (*Schweizerische Bauzeitung*, August 24), by Professor A. Paris, of Lausanne, in presence of Federal authorities. The post had a height of 6 m. above ground, 1.5 m. being in the earth; microscopic fissures were noticed during the load test, when the deflection near the top amounted to 76 mm.; rupture followed 10 minutes after the deflection had risen to 146 mm., the lateral load being 211 kg. per square centimetre, which corresponded to three times the specified strength of 70.5 kg. per square centimetre. Another post for high-tension lines, 8.95 m. high, built up of four columns with $4 \times 2 = 8$ reinforcement rods, stood a lateral load of 1,600 kg., when the foudation gave way; the maximum deflection recorded was 50.5 mm. The test proved that these brick-concrete pillars were not inferior to monolithic concrete structures.

Ukraine Waterways Commission.—Those circles interested in trade between Germany and the Ukraine, especially the Baltic towns, are at present occupying themselves, according to German journals, with the development of the waterways connecting these two countries. A Ukraine Commission for this purpose has already inspected the German waterways, and is in communication with the various municipal authorities, who are in sympathy with their plans. In the Ukraine the desire is to develop the old water route between that country and the Baltic, the Dnieper–Pripyet–Vistula route, into a modern waterway for large ships, more particularly so as Danzig is the chief outlet harbour for the south-western railways. This would connect Kherson with Danzig by a continuous water route, and be of material advantage both to Germany and the Ukraine. At the present time the Ukrainian Government is considering three distinct water routes: to Riga, Königsberg, and Danzig respectively. The connection, however, between the Dnieper and the Vistula offers the shortest route between the Black Sea and the Baltic, and at the same time would permit large barges being despatched direct from Kiev to Hamburg and Berlin. The Vistula is already connected with the central German water system, whereas in the case of Riga and Königsberg this connection would have to be made, or goods would have to be transhipped by sea. The connection also exists already between the Vistula and the Bug for small barges. This water route would likewise be of great importance for Poland, as it could obtain its food supplies from the Ukraine, and at the same time forward to that country its industrial productions by means of it.

ELECTRIC TRACTION ON THE CENTRAL ARGENTINE RAILWAY.

(*Concluded from page 459.*)

As the passenger service on the lines to be electrified is frequent and suburban only, the rolling-stock equipment was naturally laid out on the multiple-unit system. The stock ordered was as follows :—

ROLLING STOCK.

Fifty-five motor coaches, each equipped with two motors.

Twelve motor coaches, each equipped with four motors.

Fifty trailer coaches.

All the coaches are of the saloon type with cross-seats, Fig. 14, above, showing the interior of a first-class conveyance.

There are two classes of seating accommodation on the suburban trains in Buenos Aires, first and second, but the distribution of passengers between them differs from that obtaining in this country, inasmuch as the ratio of higher to lower class tickets sold is of the order 1·4 to 1. Consequently a larger proportion of first-class coaches is required and the numbers ordered for the electric service were :—

First class : 52 motor, 37 trailer coaches.

Second class : 15 motor, 13 trailer coaches.

All the coaches equipped with four motors are first-class coaches. These will be used for hauling trains made up of a motor coach at each end and between them six first-class trailer coaches taken from the old steam stock and equipped only with control wiring to allow of the train being operated from either end by one man. These trains will be used on days of specially heavy traffic, the principal of which is Tigre Regatta day, when 9,000 people have been moved by steam trains from Tigre in 2 hours.

The limiting features in designing the coaches were :—

(*a*) The high standard of comfort to which suburban passengers in Buenos Aires are accustomed.

(*b*) The provision of vestibule connections between coaches.

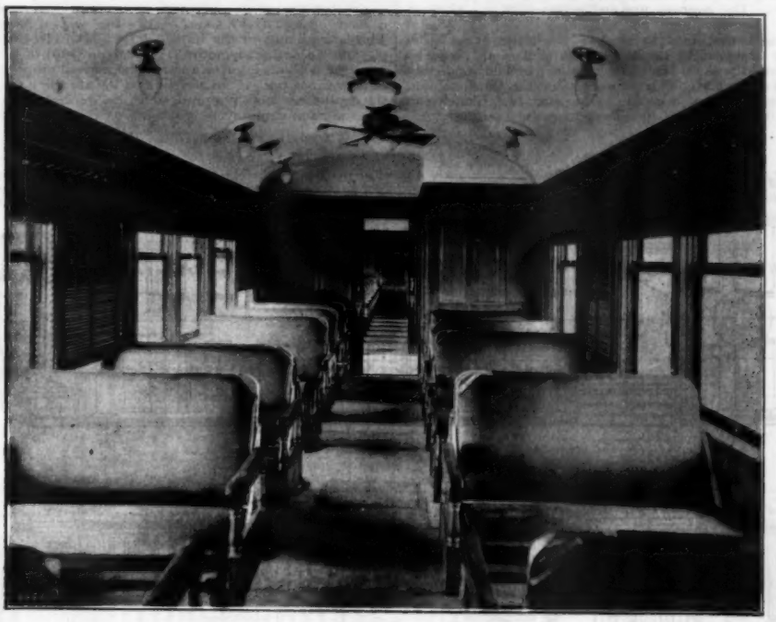


FIG. 14. INTERIOR OF FIRST-CLASS COACH.

FIG. 15. EXTERIOR OF FIRST-CLASS MOTOR COACH.

(*c*) The existence of low platforms necessitating steps up into the coaches.

(*d*) The provision of a driving compartment at each end of every coach.

(*e*) The use of vacuum brakes.

As is particularly desirable in a hot climate the coaches are large and airy, the capacious loading gauge adopted by the broad-gauge lines in the Argentine allowing more latitude in this respect there than in this country. The height from floor to centre line of the semi-elliptical ceilings of the saloons is 8 ft. 7½ in., and the width between pillars is 9 ft. 7½ in. Eight 6-in. ventilators are fitted in the roof, and four 38-in. fans are installed in the first-class coaches. The lower side lights slide upwards and all windows are provided with upper and lower louvred shutters in place of blinds to keep out the sunlight. The shutters are covered with fine-mesh copper wire gauze to prevent the entrance of mosquitos (Fig. 15).

The minimum space which must be provided for each seated passenger is definitely set out in the Government Regulations, the requirements being that the distance between seats set *vis-a-vis* shall not be less than 15½ in. and that the length of seat shall be at least 18½ in. and 15½ in. per passenger in first and second-class coaches respectively. Further, the gangway between seats shall be not less than 21½ in. wide.

Besides the provision of two classes of accommodation the Government Regulations call for at least one W.C.-compartment on every local train. Space had also to be reserved in a certain number of coaches for compartments for the use of the postal service and for luggage. These requirements were met by a W.C.-compartment in each first-class motor coach (Fig. 16), and postal, luggage and W.C.-compartments in the second-class motor and trailer coaches (Fig. 17).*, page 506.

The height above rail-level of the platforms on the Tigre line varies from about 6 in. to 20 in. The height above rail-level of the motor coach floor is 4 ft. 2 in. and the Government Regulations call for three intermediate steps. A door is provided at each end of the coach and also one in the middle. The latter is double the doorway being 5 ft. wide, and intended to take two persons abreast, the streams being separated by the central door post. As the doors have to be set back from the side line of the coach it was not possible to arrange the sills to run beneath the body sides from headstock to headstock, or even between bolsters. In the case of the motor coaches (Figs. 18 to 25 on our two-page engraving, Plate XL, in this week's issue) the main longitudinals are therefore spaced at a width of 7 ft. and consist of built-up fish-bellied steel girders 2 ft. 6 in. deep in the centre with holes cut out of the web for lightness and to facilitate access to the electrical equipment. These main longitudinals run from headstock to headstock ; they support the angle-bar sills, which are interrupted to clear the footsteps, by means of pressed steel brackets. The main members of the trailer underframes, which are of the Livesey-Gould type, are two 12-in. channels spaced 3 ft. apart and running from headstock to headstock ; they are stiffened with king and queen trusses, and support the body sills by means of transverse cantilevers.

The motor coach floors are of steel plates, $\frac{1}{16}$ in. thick, stiffened with indentations ; the plates are covered with "Induroleum," a non-inflammable composition which was laid at the builder's works, the whole underframe being shipped in one piece with the floor in position.

The trailer coach floors are pitch pine, in two layers ¾ in. thick.

The end vestibules of the coaches are arranged to serve either as entrance ways for passengers or as driving compartments for the motor men. They are 4 ft. wide, and contain the driver's brake valve, master controller and hand-brake wheel. As the English rule of the road is observed on the railways in Buenos Aires, and the wayside platforms are not of the "island" type on the Central Argentine Railway's suburban lines, the driving position must be on the left-hand side of the train in order that the motorman may see the guard's signals without leaving his position ; accordingly the brake and master controllers are mounted on the near (or left-hand) side of the vestibule—the hand brake, which is normally operated only when entering termini, is reached by walking across the vestibule. Duplicate doors are provided so that when the vestibule is used for passengers the electrical gear is all closed off. When used as a driving compartment the step-well is covered by a $\frac{1}{16}$-in. thick chequered fall-plate hinged to the door closing the opening in the side of the coach. A removable circular seat of the "music stool" type is carried by the fall-plate, the end of the leg being placed in a hole in the plate.

In the motor coaches the vestibule also contains the panels carrying the switches for auxiliaries, *e.g.*, lighting, control circuits, brake circuits, relays, &c., and also sundry tools, viz., short-circuiting bar, hammer, pliers, rubber gloves, &c.

The concealed framing of the coaches is pitch pine ; all exposed framing and the finish of the outside and of the vestibules are of teak. The interior finish of the first-class coaches is light wainscot oak and of the second-class coaches pitch pine. The ceiling sheets are white millboard on red deal matchboarding. The reversible seats in the first-class coaches are upholstered in rattan ; the fixed seats in the second-class coaches are framed with pitch pine slats. The roof sticks are ash or elm with 10 carlines of 3-in. by 2-in. angle bar, and the roof boarding is red deal covered with canvas. The sides and ceilings were shipped in two sections ; the ends of the coaches and the partitions were shipped whole, all being packed in zinc-lined cases.

The coaches are lighted by three two-light fittings, with Holophane glass globes down the centre of the ceiling, and eight pendants down the sides of each saloon. A single light pendant is fixed above each entrance and a headlight, two signal lights and an illuminated destination indicator are provided on each end of each coach.

Brake Equipment.—The service duty required the provision of a pump for each two-motor equipment, capable of exhausting 50 cub. ft. of free air per minute ; under working conditions of joint and valve leakage this equipment produces a 20-in. vacuum in the train system within 22 seconds after complete destruction. The brake equipment is laid out to provide a braking force of 105 per cent. and 95 per cent. of the tare weight of the motor and trailer coaches respectively. The two brake cylinders on each motor coach are 24 in. diameter

* Since the service started the Government has agreed to the removal of the W.C.-compartments from the first-class coaches

and the capacity of each is augmented by a vacuum reservoir. In the four-motor coaches space could not be reserved for the reservoirs beneath the underframe, so they were slung between the roof and ceiling in the centre vestibule. The operating gear consists of a partial rapid-acting valve, an emergency valve, and the driver's brake valve and controller. A Simplex gauge shows the pressure in the train pipe and a vacuum horn is connected up to the system to take the place of the whistle or bell used for signalling purposes on steam lines.

Motor Bogies.—Views of the motor bogie are given in Figs. 26 to 31, on page 496, and in Fig. 32, page 507. The side frames (Fig. 28) are built up of ⅝-in. plate reinforced at the top by angles and at the bottom, between wheel centres, by channels. The headstocks are 10 in. bulb angles and the central cross-member consists of two channels, 15 in. deep superposed on two 6-in. channels, the latter forming a step or ledge 4½ in. wide beneath the suspension springs of the motors. Diagonal stiffness is ensured by the insertion of upper, lower and intermediate sets of horizontal gusset plates riveted to the central cross-member and to the channel and angle-bar stiffeners of the side frames. The connection of the headstocks to the side frames is made through corner gussets and wrappers. The bolster is built of two 10-in. channels with top and bottom cover plates $\frac{7}{16}$ in. thick. The bolster springs are of helical form, with inner and outer coils 12 in. diameter outside. The centre pivots and side bearings are of cast steel. The horns of the side frames are reinforced with plates ⅜ in. thick applied externally; the horn blocks are of cast steel and are fitted with gun-metal wearing strips extending over the face and edges. The axle boxes are of cast steel fitted with gun-metal bearings lined with white metal and with malleable iron centre-bearing keys. Each box is cast with a wing bracket at one side to take the end of the collector shoe beam. The bearing springs are of the laminated type with solid eyes, the hangers are fitted with auxiliary indiarubber springs of the oval concentric type.

The brake heads are of cast steel, each fitted with a cast-iron shoe which is secured in place by a tapered key of the standard form, with the addition of a tail piece extended downwards so as to be readily accessible from the car shed pits.

The arrangement of brake rigging shown on Plate XL was adopted in order to ensure a uniform force being exerted on all blocks with pressures evenly distributed along each pin without any tendency to cross-bind or produce torsional stresses in the levers. The leverage of this rigging is 8 to 1. In order to provide automatic compensation for wear of the brake blocks three sets of six coaches each were fitted with three different types of slack adjuster—the Monarch, Hills' and the nut and ratchet type. The latter consists of a tubular nut fitted in the main pull rod and rotated by a pawl and ratchet; the box which carries the pawl is formed with a segment of a toothed mitre wheel which gears with a similar portion carried on a vertical stud attached to the crosshead at the end of the pull rod. The periphery of the second mitre wheel is anchored to the underframe by means of pitch chains which thus cause it to rotate in response to the travel of the pull rod. The range of the gear is sufficient to allow the brake piston to make a full stroke when operating through a badly adjusted brake rigging, and thus to gather the slack till the normal condition is reached. When the brake is released the pawl will cause a partial rotation of the nut whenever the working stroke is sufficient to turn the mitre gears through an angle of 60 deg.

The collector gear consists of an under-running shoe (Figs. 33 to 36, page 507) which makes contact with the under surface of a channel shaped conductor rail. The shoe casting is carried on an oak beam fixed to lugs on the axle-boxes. The collecting skate has two motions:—

(*a*) An up and down movement to follow the level of the conductor rail; this is controlled by helical springs on a horizontal axle passing through the block to which the skate is bolted.

(*b*) A sideways movement to allow for the end play of the axle boxes and want of alignment of the rail; this is controlled by leaf springs bearing on the suspension links of the skate.

The difference in the heights of the top of the skate in its extreme positions is 2½ in.; its horizontal movement is 3 in. The average upward pressure of the skate is 28 lb. The shoe body and suspension links, Fig. 35, are cast steel, machined to gauge; the skate is cast-iron and is designed to break when it strikes an obstacle. If desired the skate can be locked down in such a position that it clears the conductor rail altogether, thus enabling the equipment of a coach to be isolated. Skates run about 130,000 miles before becoming worn out.

modified in the case of subsequent deliveries, the spacing of the body partitions and the detail of the bogie having been made similar to those of the motor coaches.

Electrical Equipment of Trains.

The average distance between stations on the Tigre (Victoria) route is 1¼ miles; the present timing of electric trains which stop at all intermediate stations is 47 minutes, giving a scheduled speed of 22½ m.p.h. This can be increased to 25 m.p.h. when desired without overloading the equipment. As the average length of run is comparatively great, and as there are no severe gradients on the line, it was not necessary to utilise the whole of the weight of the motor coaches for adhesion by gearing a motor to each axle. Consequently a two-motor equipment was adopted, each motor dealing with a load of about 45 tons. With the width between wheels available on the broad gauge (5 ft. 6 in.) it was possible to design a motor (Figs. 27 and 29) of ample capacity without interfering with the normal proportions of its various parts. In addition to the stopping service the trains are also required to make express or semi-express runs stopping only at one or two intermediate

Fig. 16. 1ST CLASS MOTOR CAR.

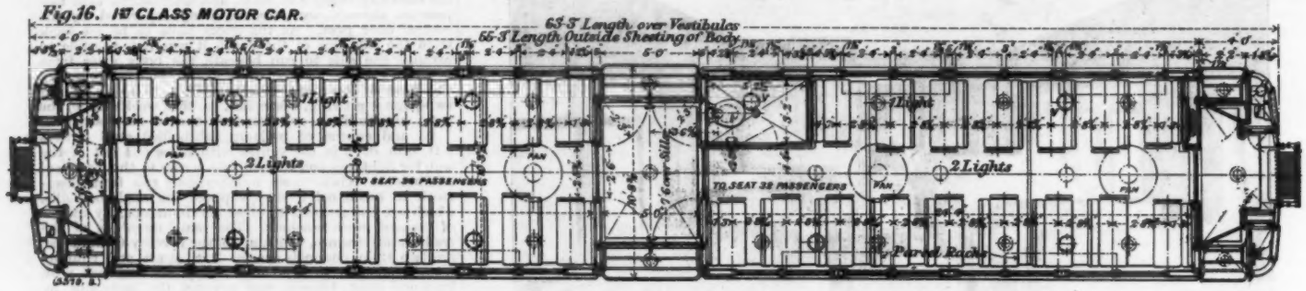


Fig. 17. 2ND CLASS TRAILER.

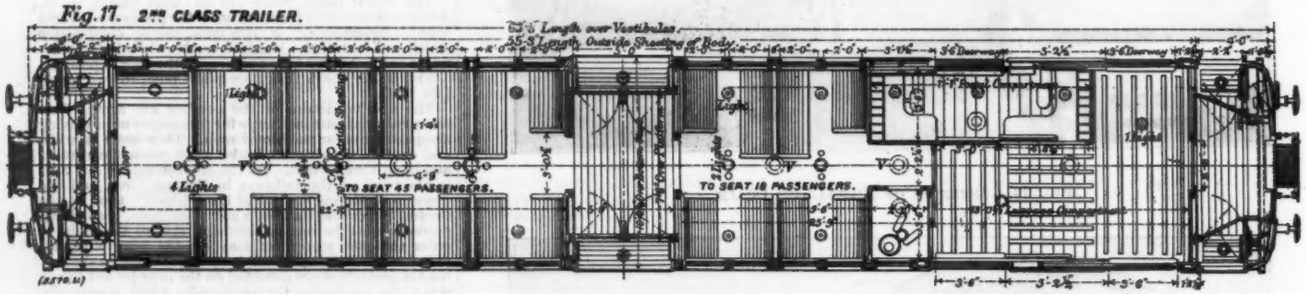


Table VI gives details of the rolling-stock:—

TABLE VI.—*Details of Rolling-Stock—Gauge of Rails, 5 ft. 6 in.*

Coaches.	Motor Coach. Ft.	Motor Coach. In.	Trailer Coach. Ft.	Trailer Coach. In.
Length over buffers	65	3	65	3
Length over headstocks	61	11	61	11
Length over body	63	3	63	3
External width of body	10	3½	10	4½
Height from rail to centre of buffer	3	5	3	5
Height from rail to top of roof ...	13	2½	13	2½
Height from rail to floor	4	2½	4	1½
Height from floor to ceiling ...	8	7½	8	7½
Distance between centres of bogies	40	0	40	9
Number of first-class passengers seated	72		68	
Number of second-class passengers seated	66		63	

Bogies.	Motor Coach. Motor Bogie. Ft.	In.	Motor Coach. Trailing Bogie Ft.	In.	Trailer Coach. Ft.	In.
Wheelbase of bogie ...	9	0	8	6	8	6
Diameter of wheels ...	3	6	3	3	3	3
Diameter of axle at centre	0	7	0	5½	0	5½
Size of journal ...	10 in. × 3½ in.		9½ in. × 4½ in.		8 in. × 4½ in.	
Distance between centres of journals	7	6	7	3	7	3
Width over side frames	6	10½	6	9	6	9
Length over headstocks	14	8	13	9	13	9

Weight of Rolling-Stock (Empty).

	Two Motor Coaches. Tons.	Four Motor Coaches. Tons.	Trailer. Tons.
Coach body, underframe and bogies	39·0	40·5	33·2
Electrical equipment ...	11·5	20·5	1·3
Total weight ...	50·5	61·0	34·5
Weight per passenger seat	0·74 ton	0·84 ton	0·48 ton

Note.—The design of the trailer cars has been slightly

stations and performing the journey at a scheduled speed of 37½ m.p.h. This condition is provided for by reducing the excitation of the main fields by 50 per cent. in one step. Details of the electrical equipment of the coaches are given in Table VII.

TABLE VII.—*Details of Electrical Equipment of Rolling-Stock.*

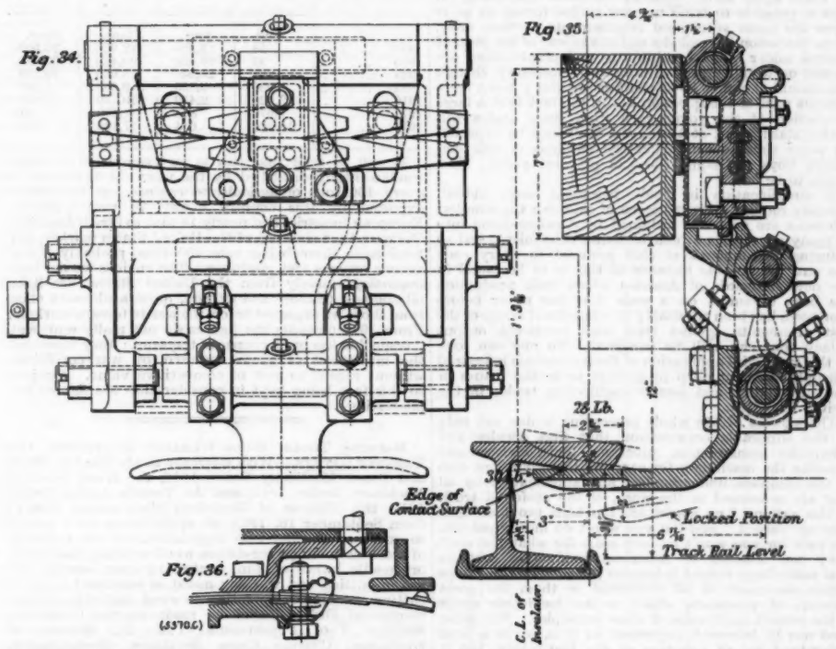
Type of motor	G.E. 235.
Horse-power of motor	250 h.p. on 1 hour rating (75 deg. C. rise).
Voltage across motor	800.
Overall length of motor ...	5 ft. ¾ in.
Diameter of armature	20 in.
Core length	17½ in.
Diameter of commutator ...	17½ in.
Length of commutator... ...	7½ in.
Weight of motor, including gears and gear case	8,430 lb.
Armature bearing (pinion end)...	5 in. by 11½ in.
Armature bearing (commutator end)	4½ in. by 8½ in.
Gearing—pinion	22 teeth; 2½ in. diametral pitch; forged steel, oil tempered.
Gearing—gear wheel	70 teeth; width of face 5½ in. Cast steel hub with oil-tempered forged steel rim shrunk on.
Wheel diameter	3 ft. 6 in.

The two motors mounted on each motor bogie are arranged for nose suspension from the bogie transom, the suspension nose being cushioned by springs against both upward and downward movement; they drive the axles through single pinions and gears with a gear reduction of 70·22. The clearance between the lowest point of the cast-iron gear-case and rail-level is 4½ in. The suspension bearings on the axle are fitted with gun-metal linings, the length of axle between bearings being protected by a housing to exclude dust. The armature bearings are gun-metal lined with white metal. Both sets of bearings are lubricated with oil and waste.

The motor carcase is a single steel casting with machined seats for the four main and four commutating poles.

Provision for ventilation is made in the form of a rectangular opening of 160 sq. in. at the pinion end, arranged to take a flexible duct communicating with the interior of the coach, through which the air can be drawn if it is found that there is too much dust in the air taken direct from beneath the coach. The air entering bobbins. The main circuit breaker which can be set or tripped from the driver's cab, and the reversers are mounted in watertight sheet-steel boxes. All cables beneath the coaches are carried in solid drawn steel conduit, screwed into the cases containing the apparatus; where breaks are required in the cable junction boxes

FIG. 32. MOTOR BOGIE.



this opening passes to the commutator end between the fields and over the surface of the armature; it then returns through ducts in the core and is expelled through openings in the upper part of the end shield by a fan fixed on the armature shaft. All other openings in the carcase are fitted with watertight covers.

The armature core stampings are mounted direct on the shaft and can be kept solidly together when being pressed off by bolts passed through some of the ventilation ducts. The armature coils are made up of flat strips insulated from each other with mica, bound together with tape, and insulated from the core with pressed mica. The field coils are copper strip, the main coils being wound on the flat and the commutating coils on edge.

The two brush holders each carry four carbon brushes, the pressure on which is adjusted to 4½ lb. Each holder is carried off two porcelain insulators, the stud insulation being mica.

The motors are built and insulated for a working pressure of 800 volts, and the control system provides for operating with two motors in series, in parallel with full field, and in parallel with tapped field. The control at starting is automatic, the rate of cutting-out series resistance being determined by a "notching" relay which allows the contactors to close in the proper order as the main current falls to a predetermined value. The main contactors are wound to operate with any line voltage from 480 to 850. They are 15 in number and are mounted in a sheet steel box with the front covers hinged to swing open in case of heavy arcing. The interlocks (Fig. 37) which make the combinations required for the successive control steps are mounted on spindles at the back of, and are operated by, the contactor arms. The main resistances are cast-iron grids insulated with mica and mounted in frames carried from the underframe members by insulated bolts and

are provided. The conduit was erected in this country and shipped in position on the under-frame, the cables being pulled in during the re-erection of the coaches in Buenos Aires.

The leads which run from end to end of the train are three in number:—

(a) The train line, a single core cable.

(b) The pump line, a twin-core cable, one core being the full speed and the other the half-speed lead for the pump motor.

(c) The control line, a bundle of seven cables coupling up controllers, circuit breakers, &c.

These leads bifurcate at the end of each coach and terminate in sockets attached to the headstock. Connection between coaches is made by removable jumpers and plugs.

The vacuum pump and motor are mounted in a framework slung to the underframe. The pump is a single-acting two-cylinder machine coupled to the motor through a helical spring coupling. It is geared down 4:1 by a chain inside the pump casing. The motor is of 3½-h.p. capacity, series wound. A series resistance which can be short-circuited permits it to be run at two speeds, one approximately double the other. Normally the motor is run at half-speed to maintain the vacuum against leaks and the use of the vacuum horn; when the driver's brake handle is put into the "release" position the brake controller cuts out the resistance and the motor runs at full speed till the required vacuum is obtained, whereupon the brake handle is put to the "running" position, thus inserting the resistance again into the circuit. There are four positions of the driver's brake handle:—

1. Neutral position ...	Motor stopped; train and pump pipes not connected together.
2. Release position ...	Motor running full speed; train and pump pipes connected through full gate in driver's valve.
3. Running position...	Motor running half-speed; train and pump pipes connected through half-gate in driver's valve.

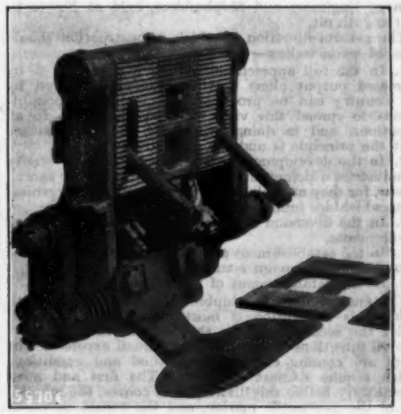


FIG. 33. COLLECTING SHOE.

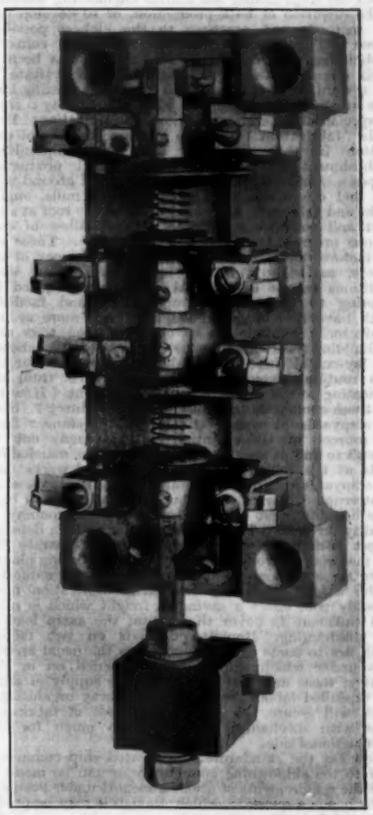


FIG. 37. CONTROL INTERLOCKS.

4. Application position	Motor running half-speed; train pipe full open to atmosphere; pump pipe blanked off.

The "dead man" device on the controller consists of a pilot valve operated by a knob on the main handle. When the knob is released this valve admits air to the emergency valve, which is thus actuated and opens the train pipe to atmosphere, blanking off the pump pipe.

THE INSTITUTE OF MARINE ENGINEERS.—We are glad to announce that H.M. the King has been graciously pleased to accept the invitation of the Office Bearers and Council to become The Patron of the Institute of Marine Engineers. It is gratifying to marine engineers that this honour has been conferred on the Institute, and it may be accepted as a recognition of the national work which has been and is being done by the Institute.

RECONSTRUCTION OF THE SHIPBUILDING INDUSTRY.

We make the following extract from the presidential address delivered by Mr. Edwin L. Orde at the opening meeting of the session of the North-East Coast Institution of Engineers and Shipbuilders, held at Newcastle on the 25th ult.

The general direction in which reconstruction should proceed seems to lie :—

1. In the full appreciation of the fact that it is by increased output alone that the revenue required by the country can be produced, in making all possible efforts to spread this vital piece of knowledge in all directions, and in doing everything necessary to see that the principle is understood and acted upon.

2. In the development in the order of their necessity of industries which produce the requisites of peace as well as war, for they are valuable revenue-producing organisations which are immediately available.

3. In the diversion of purely war industries to peace requirements.

4. In the establishment and development of industries recovered from foreign countries.

5. In the establishment of new industries.

The engineering and shipbuilding organisations with which this Institution is most closely concerned fall under the second head, as they can be fully diverted to civil directions at comparatively small expense; but there are coming changes of method and conditions which require earnest attention. The first and most urgent duty before this district is, of course, the rebuilding of the mercantile marine, and the consideration of the most rapid methods by which this work can be accomplished raises at once one of the many important questions which are before us to-day. Are we to remodel our shipbuilding and marine engineering industry in the direction of bulk production, or to develop pre-war methods and practices to the highest possible degree? The question involves the three coins of shipbuilding conversation on which there has been so much discussion as would make anyone hesitate to add a word, were it not for the important bearing they have on the well-being of the whole community: these are specialisation, standardisation and fabrication. How far is 'fabrication" likely to increase the rate of production in this country? The ideal shipbuilding establishment for rapid and economical production purposes would naturally be a long strip of ground with coal and ore mines, steel works, rolling mills, engine works and shipyards, all arranged under one roof at such short and convenient intervals as shall allow of continuous progress from ore to finished ship. These are the factors that define the mechanical efficiency of the system, and should be considered first. Now ideal conditions cannot be attained or even approached by adapting to new methods appliances and facilities which have been designed for, and fulfil more or less satisfactorily another set of conditions, so that new shipbuilding yards seem to be essential to the scheme. The lay-out of these new yards should provide for the even routine passage of the various parts from the fabricating to the shipbuilding establishment. How far can these conditions be fulfilled in this country? Sites for shipyards at comparatively short distances from the sources of the essential materials may not be difficult to find, it may be possible to arrange marshalling yards at the rolling mills, the fabricating works and the shipyards on such a liberal scale as to produce an uninterrupted flow of parts, but when all this has been done has any great advance been made in economy or rapidity, or both. The economy of the system depends almost entirely on the distances which separate the raw material, the rolling, fabricating and erecting plants. When these are long as in America, the large reduction in the weight of the material after fabrication may, probably will, effect a saving in freight which is more than sufficient to cover the cost of the extra loading and discharging. Rapidity depends on two factors which are to some extent opposed to the usual restrictions under which shipbuilding is carried on in this country, these are, first: A very large supply of semi- and unskilled labour; secondly, a railway organisation which will secure the constant transfer of fabricated parts with mechanical precision. So much for the constructional side.

How far the standardised fabricated ship commends itself to the shipowning community or can be made to fulfil the requirements of ocean transport under post-war conditions is a question, which, though it may be profitable to debate, depends on too many unknowns to be answered with any certainty. It is to be hoped that these questions may be treated at length during the session, for there is ample ground for discussion, and general opinion, now perhaps somewhat fluid, needs consolidation.

The important conditions that affect the problem may perhaps best be indicated by one or two questions. How far can bulk production of ships and engines meet: (a) The immediate requirements for tonnage; (b) the future developments of shipping; and how far can bulk production be reconciled with: (c) The apparent desire to shorten the hours of labour; and (d) the aspiration to raise the intellectual standard required of labour in industrial processes. The generally existing prejudice against bulk production in shipyards, though not nearly so strong as it was when State shipbuilding processes were first introduced, has by no means disappeared; and there are standardists and specialists wherever shipbuilders and marine engineers are to be found whose views, though like many or most of the strong trade convictions, which are the outcome of personal experience, tradition and a laudable desire for improvement in detail, have never yet been seriously attacked by such broad economic considerations as must guide this important section of the industrial community at this juncture.

Now (a) and (c) though of paramount importance, seem to constitute strong arguments in favour of bulk production, for nothing but rapidity of production can meet these requirements, but (b) and (d) present some slight difference and may be said to indicate the specialist principle which can more easily be applied when the first great demand for the replacement of cargo-carrying tonnage has been met. It would seem on the whole that bulk production must at first be carried on, but carried on heartily and loyally, to meet the immediate needs of the nation, that during this period all that constitutes an impediment to simplicity and to speed and economy of production shall be examined and, so far as possible removed, so that special types may be easily produced as and when the development of the world's trade makes them necessary. These are ideals which may be called impossible of attainment, a combination of the technical and the social which is one of the most important of the lessons set to us by the war, and at the same time one which those whose industrial condition and outlook remains least changed will find the most difficult to learn.

The immediate future of the shipbuilding and engineering trades from the technical point of view demands careful consideration, for the ordinary supply of young, skilled men has been materially reduced, cannot be augmented for some time to come, and so must be husbanded as carefully as possible. This constitutes a strong argument in favour of bulk production, where by simplifying all the processes to the utmost the demand for high skill can be kept low and opportunity given to the trades to meet the immediate demands that will be made upon them, while at the same time doing all that is possible to build up new skilled forces, so as to meet the more specialised requirements as they arise. Some extension beyond the end of the war of the present control under which engineering and shipbuilding are carried on would seem therefore to be necessary, though this should of course be as short as possible; but a more difficult part of the question lies in the fact that a large proportion of the young men from these trades will never, alas! work at them, and it cannot be expected for some time to come that the numbers of able and willing boys will equal those of previous years. How is this to be met?

A simplification in trade processes may, indeed, logically require a lower degree of skill, for the simplest processes are generally obtained by dividing them into as many operations as can be found convenient, and so reducing the amount of skill required to carry each one out. A notable instance of this is to be found in the new shipyards of America where bulk production has been organised on a scale that has never before been seen, has been admirably developed and is one of the best arguments against that fatal restricted output fallacy that can well be imagined. No one can look on this successful application of these economic industrial principles without deep misgivings as to the future of the shipbuilding and marine engineering trades in the United Kingdom.

The success of the whole proceeding is due not only to the admirable organisation that first decides and subdivides construction processes and devices and provides the machinery for carrying them out, but also to the complete understanding and appreciation by all who are concerned in the work, of the profound truth of the axioms "no wages are too high provided that they are earned," and "if you won't do more than you are paid for you won't be paid more for what you do." They are features of American productive schemes that make large output industries the rule, and so brings within the reach of all concerned in them the great measure of prosperity which is the inevitable result of the correct application of these principles. The point need not be laboured, important as it is, for it is well understood by all members of the Institution, but if illustration is required it is to be found in the discussion on "Factory Organisation" in the Transactions. Like many other sound principles they recoil heavily on those who disregard them, and as the whole tendency of the present spirit of the time seems to be in that direction there is good ground for misgiving as to the future of any trade carried on in this country unless, indeed, a more scientific economic outlook can be developed. One of the curious anomalies of the social system in this country is to be found in the fact that, although almost any individual will extol the results achieved by science, and regret that students are comparatively few, the community generally seems to have combined, no doubt unconsciously, to stifle any attempt on the part of the votaries of science to make their voices heard in the councils which regulate mankind's affairs, and to this disability may perhaps be attributed much of the neglect of first principles which is so painfully and widely evident to-day. It would seem unnecessary to state that under the head of science, which is after all only knowledge, everything that is worth knowing is included, hygiene and domestic economy, for instance, whose simple laws are violated to an extent which reflects severely on the education administered in this country for the last few decades. It is not suggested that such institutions as this are responsible for these conditions, but as much has been done by them in the way of promoting the cause of education, it seems well to consider how they can help in other directions.

IMPORTS AND EXPORTS.

The September returns may be summarised, so far as the net effect on supplies of engineering material is concerned, as a general decline in imports which is more than balanced by a decline in exports. This is in accord with the general tendency of the previous months of the year. Assuming that our home production has not declined, we have a substantially increasing supply for working up. The most probable inference is that the allied nations have adjusted their mutual contributions so as to make the burden as light as possible on shipping. In imports of machinery there is a general decrease, except that agricultural engines and machines are still coming in freely; machine tools largely, but at a decreasing rate, and aircraft heavily. The value of imported aircraft for the nine completed months of this year is 4,895,000*l.*, as compared with the almost nominal figure of 100,000*l.* for the same period of 1917. There is no information in the returns as to whether these are complete machines or parts, or whether the parts are wood or metal. Our total exports of machinery are falling considerably, but the items of rail and road locomotives and reciprocating engines are well maintained, while boilers and machine tools are exported in considerable though lessened quantities. In all these comparisons (except aircraft) we consider figures of tons weight, as a safer index than money values under present circumstances. With aircraft the only figures available are money values.

It is perhaps not generally understood that our pre-war foreign trade in agricultural engines and machines was of considerable value, especially in substantial metal structures of lasting quality. The figures for a few years before and during the war are instructive.

Agricultural Engines and Machines.

Nine Months Jan.-Sept.	Engines.		Machines.	
	Imports.	Exports.	Imports.	Exports.
	tons.	tons.	tons.	tons.
1910	58	23,450	12,920	33,560
1913	93	20,420	20,420	35,960
1914	208	24,540	18,960	29,290
1915	985	3,150	9,680	5,380
1916	2,628	2,450	10,150	3,900
1917	9,870	878	11,610	1,040
1918	16,820	684	17,120	570

It will be seen that this is an example of a trade fundamentally disturbed by the war. In 1910, out of every 100 tons of agricultural engines and machinery exported by this country nearly 70 tons went to European countries and nearly 10 tons to South America. We were then shut out of the United States market, our total sales there being only 200 tons, probably a few sample engines and machines. The engines we are now importing, mainly from the United States, are light oil engines, tractors and drivers, quite a different class from those we exported before the war to foreign markets. From 1915 onwards the figures do not really represent "trade" in the proper sense of the word; they represent the movement of goods required by war conditions without regard to cost of competitive value. Subject to this fact being kept in consideration the figures are interesting.

Machine Tools, Wood-Working Machinery and Treadle Lathes.—With reference to the Machine Tools and Power Machinery Order, 1916, the Wood Working Machinery Order, 1917, and the Treadle Lathes Order, 1918, the Minister of Munitions gives notice that as from September 16, 1918, all applications for a permit to purchase or enter into negotiations for the purchase of machine tools, power-driven wood-working machinery, or treadle lathes of 3-in. centres or over, suitable for use in cutting and working metal or suitable for use in cutting, working or operating on wood, under the above-mentioned Orders, must be made to the Controller, Machine Tool Department (T.M. 7), Ministry of Munitions, Charing Cross Buildings, Embankment, London, W.C. 2.

Returns as to Forgings and Castings.—The Minister of Munitions, in pursuance of the powers conferred upon him by the Defence of the Realm Regulations and all other powers thereunto enabling him, orders as follows: (1) Every person engaged in the production of ferrous forgings or drop forgings or castings shall furnish to the Controller of Forgings and Castings, Ministry of Munitions, 8, Northumberland Avenue, London, W.C. 2, such particulars as to output, plant and workpeople employed by him, and as to his orders and contracts in such form and at such times as the Controller of Forgings and Castings on behalf of the Minister of Munitions shall from time to time direct, and shall verify the same in such manner as the said Controller may require. (2) This Order may be cited as the Ferrous Forgings (Returns) Order, 1918.

Oil Explosion Motors.—The Paris journal *Moniteur de la Flotte* says that two French engineers, Messrs. Bellem and Brégéras, have devised a means for using heavy oil in petrol engines. They have solved the difficulties surrounding the problem by providing a new process of carburetting, which consists in dividing into two phases the first stroke of the four-stroke cycle. During the greater part of the first stroke, the air valve is closed. The cylinder is provided at top with an atomiser through which are drawn air and oil, which latter is finely atomised in the vacuum. The spray, together with the air which enters after the spray, is produced forms an explosive mixture which detonates under the action of the usual spark. A new fuel distributor yields the accurate amount of oil needed. The new device has given excellent results in actual working. The cost of the new fittings required is approximately equal to that of a petrol carburettor.

ELECTRICAL RESISTANCE OF HARDENED STEEL.*

On the Rate of Change at 100 Deg. C. and at Ordinary Temperatures in the Electrical Resistance of Hardened Steel.

By E. D. Campbell, Ann Arbor, Michigan.

Although the electrical resistance of steel and other alloys is now almost universally recognised as being primarily dependent on the chemical constitution of the solid solution of which the steel is composed, this dependence of the specific resistance on the chemical constitution was not clearly recognised by chemists and physicists until about thirty years ago, when the solution theory of steel became effective as a working hypothesis.

Hardened steel has for a long time been considered as consisting of a more or less saturated solid solution of carbides and other solutes which are, partially at least, precipitated if the metal is reheated and slowly cooled, that is, annealed. The extent to which the electrical resistivity of hardened steels is changed by careful annealing—that is, the influence of those solutes which are in solution on the specific resistance of steel—has formed the basis of an enormous number of researches, particularly by metallurgical chemists, during the past thirty-five years.

While it is well known that the specific resistance of steels can be increased by bringing the carbides and other solutes into solution by sudden quenching from temperatures above the critical range, comparatively little systematic work has been done to determine the rate at which the electrical resistance changes when hardened steels are tempered by reheating to different temperatures. Since the electrical resistivity is dependent upon the chemical constitution of the steel, any study of the rate of change in electrical resistivity would serve as a means of studying rates of reaction in solid solution. The most extensive work which has been published dealing with the rate of change in electrical resistivity of hardened steels when these latter are tempered at different temperatures was that carried on by Barus and Strouhal† about thirty-five years ago.

The object of the present paper is to furnish some quantitative data on the rate at which the electrical resistivity of hardened steels changes when the steel is reheated to a temperature as low as 100 deg. C., and even when standing at ordinary temperatures, thus furnishing some figures which will indicate the influence of temperature on the rate of reaction in the unstable solid solutions of which hardened steels are composed.

The steels were hardened and the earlier specific resistance measurements made by Walter E. Jominy, M.S., the long time measurements on the samples kept at ordinary temperatures being made successively by W. C. Dowd, M.S., and E.G. Fahlman, B.S. in Engineering.

The steels used were part of those employed in some of the research work, the results of which have been reported to the Institute in previous papers.‡ The composition of the steels used is shown in Table I.

Table I.

Steel.	H57.	C4.	C5.	C7.
	per cent.	per cent.	per cent.	per cent.
Carbon	0·57	0·76	0·945	1·05
Manganese	0·11	0·221	0·189	0·190
Phosphorus	0·010	0·016	0·013	0·013
Sulphur	0·020	0·041	0·016	0·020
Silicon	0·17	0·169	0·155	0·167

Bars of these steels a little more than 6 mm. square and 15 cm. long were suspended in an electrically-heated furnace which had been brought to the temperature from which it was desired to quench the bars. The furnace was so designed that the bars might be maintained at a certain temperature for any desired length of time without any oxidation, and the time required to transfer a bar from the furnace to the quenching bath was reduced to about 1 second. The bars were kept in the furnace 1 hour in order to be sure that they were at the same temperature as the furnace, the temperature being measured by means of a standard platinum-rhodium thermocouple, the bead of which was within a few millimetres of the bars under treatment. Quenching was effected in a large volume of water maintained below 10 deg. C. by means of crushed ice.

After quenching, the bars were removed from the bath and, after polishing, the cross-sections measured and the specific resistance determined with the same apparatus as that employed for similar work described in the articles above referred to. After measuring the specific resistance in the freshly quenched condition, one set of bars was placed in an electrically-heated drying oven maintained at a temperature of between 100 deg. and 108 deg. C., the temperature usually being between 105 deg. and 108 deg. They were allowed to remain in the drying oven 1 hour, after which they were removed and the specific resistance at 25 deg. re-determined. They were then returned to the drying oven and again reheated for 1 hour, and the specific resistance again redetermined at 25 deg. The reheating and redetermination of the specific resistance was repeated at the end of a third hour, after which the time of reheating was increased to 3 hours, and later to 6 hours, making the total time of reheating 12 hours at the temperature of the drying oven. The results of this tempering at temperatures between 100 deg. and 108 deg. are shown in Table II.

Fig. 1.

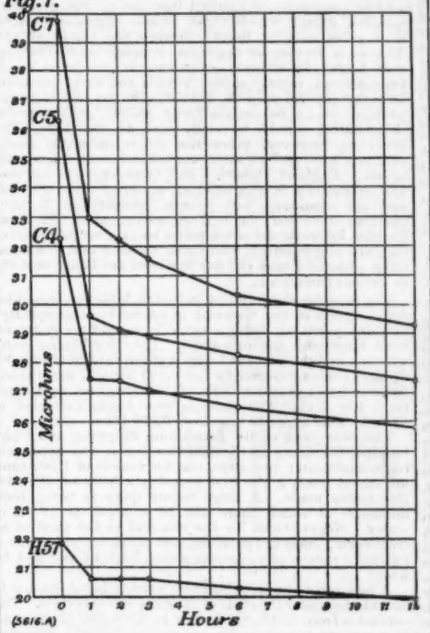
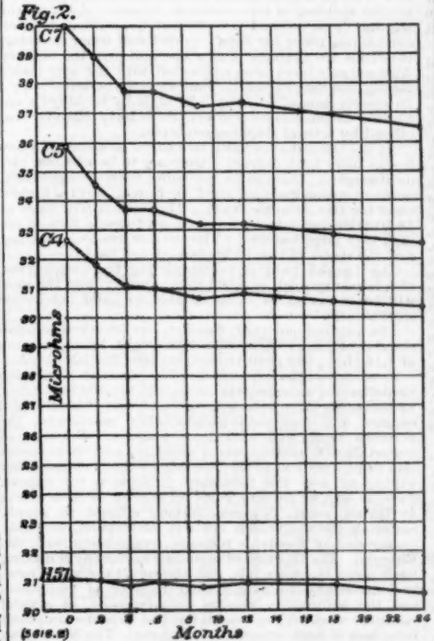


Fig. 2.



In the case of the second set of bars the specific resistance was measured, as in that of the first set, immediately after quenching, then the bars were placed in a suitable cylinder containing enough oil to cover the bars, which were then allowed to remain at room temperature. The bars were kept immersed in oil to prevent rusting, as the experiment was planned to continue for some time. When the bars had stood at room temperature for seven days the specific resistance was redetermined, and they were then returned to the oil bath and again allowed to stand, the next determination being made after a lapse of 14 days. The specific resistance was redetermined after standing at room temperature for gradually increasing intervals of time, the last determination being made after a total standing of two years. It is hoped that these measurements will continue to be made at intervals of one year, but the results of the changes in electrical resistance for periods up to and including two years are given in Table III at this time.

Table II.

Steel.	H57.	C4.	C5.	C7.
Carbon, per cent.	0·57	0·76	0·945	1·05
Specific resistivity when quenched from 907 deg. C.	21·88	32·24	36·32	39·73
Specific resistivity on tempering 1 hour at 100 deg. to 108 deg. C.	20·67	27·47	29·62	32·97
Specific resistivity on tempering one additional hour at 100 deg. to 108 deg. C. ..	20·54	27·47	29·12	32·18
Specific resistivity on tempering one additional hour at 100 deg. to 108 deg. C. ..	20·54	27·07	28·89	31·58
Specific resistivity on tempering three additional hours at 100 deg. to 108 deg. C. ..	20·27	26·55	28·27	30·32
Specific resistivity on tempering six additional hours at 100 deg. to 108 deg. C. ..	19·87	25·75	27·31	29·19
Total drop in specific resistivity in 12 hours tempering	2·01	6·50	9·01	10·54

Table III.

Steel.	H57.	C4.	C5.	C7.
Carbon, per cent.	0·57	0·76	0·945	1·05
Specific resistivity when quenched from 906 deg. C.	21·07	32·64	35·85	40·00
Specific resistivity after standing 7 days at room temperature	21·17	32·48	38·53	39·87
After 14 days	21·21	32·45	35·50	39·80
After 21 days	21·11	32·31	35·22	39·67
After 28 days	21·17	32·24	35·12	39·33
After 2 months	21·01	31·78	34·50	38·99
After 3 months	20·94	31·18	34·10	38·32
After 4 months	20·84	31·05	33·70	37·76
After 6 months	20·94	31·02	33·70	37·76
After 9 months	20·82	30·71	33·24	37·27
After 12 months	20·87	30·83	33·24	37·27
After 18 months	20·87	30·55	32·87	—
After 24 months	20·60	30·33	32·53	36·47
Total drop in specific resistivity in 24 months at room temperature	0·47	2·31	3·32	3·53

The data given in Tables II and III are shown graphically in the curves in Figs. 1 and 2.

An examination of the data given in the tables and curves shows rather strikingly the great influence of a comparatively small change in temperature on the rate of change in electrical resistivity—that is, on the rate of reaction which takes place in the unstable solid solutions constituting hardened steels. The change at ordinary temperatures after two years is only from about 35 per cent. to a little more than 40 per cent. of what it is after 12 hours at 100 deg. C. The work of Barus and Strouhal, to which reference has already been made, showed that with the rise of temperature above 100 deg. the rate is very much accelerated, and it is probable that at temperatures near or above the critical point the reactions take place at rates of the same order of magnitude as hold for reactions in aqueous solutions.

Swiss Tender Locomotives for Java.—In autumn, 1916, the Netherlands Government contracted with the Swiss Locomotive and Engine Works at Winterthur for the supply of 14 Schmidt superheater tender engines for Java, to be sent over to Tandjong Triok, near Batavia, by April, 1917. The war delayed delivery of the engines, which only reached Holland in March last. The design was made by the firm subject to the approval of the engineering department of the Netherlands Colonial Office under the direction of Mr. J. C. Schäfer. According to the *Schweizerische Bauzeitung* of September 7, the engines are to haul train loads of 400 tons up gradients of 1 in 200 over curves of 180 m. radius, at a speed of 50 km. per hour, and they are also to be capable of passing over curves of 120 m. radius where the gauge of 1,067 mm. has a widening of 20 mm.; on level ground the maximum speed is to be 80 km. per hour. The overall length is 12·790 m., the weight 49,600 kg., fully equipped 63,110 kg., weight available for adhesion 33,540 kg., maximum tractive effort 6,000 kg. The engine runs on two bogies with a total wheel base of 9,950 mm. and on six coupled wheels, the fixed wheel base being 3,000 mm.; the wheel base of each bogie is 1,800 mm., and the distance between the bogie centres 8,150 mm.; the main driving wheels have a diameter of 1,350 mm. The boiler, 1,404 mm. internal diameter, has its axis 2,450 mm. above the rail head; it is provided with a fire-box of copper and with patent-welded mild-steel tubes, and the fire door is fitted with a Marcotty smoke-combustion device. The Schmidt superheater is designed for temperatures up to 350 deg. C. The two, outside, cylinders are 450 mm. in diameters, with a 550 mm. stroke; the mouth of the blast pipe is on the pattern of the Northern of France Railway; the piston valves are of the Prussian railway pattern, and the valve gear of the Heusinger type. The steam pressure is 12 atmospheres; the grate area is 1·86 sq. m., the heating surface 135·10 sq. m., including 30·80 sq. m. for the superheater. The boiler takes 4,100 litres of water, the tank 9,000 litres. The engine carries 3,000 kg. of coal.

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* Paper taken as read before the Iron and Steel Institute on September 13.

† Bulletin 14, *U.S. Geological Survey*, 1885.

‡ "The Influence of Heat Treatment on the Specific Resistance and Chemical Constitution of Carbon Steel," Journal of the Iron and Steel Institute, 1915, No. II, pages 164 to 180.

"The Influence of Heat Treatment on the Thermo-Electric Properties and Specific Resistance of Carbon Steels," *Ibid.*, 1916, No. II, pages 268 to 285.

"The Influence of Heat Treatment on the Electrical and Thermal Resistivity and Thermo-electric-potential of some Steels," *Ibid.*, 1917, No. II, pages 251 to 262.

SCANDINAVIAN SHIPBUILDING AND SHIPPING.

THE Oresund yard at Landskrona, which will shortly be officially opened, is planned to become the largest establishment in the shipbuilding industry in Scandinavia. The concern started with the modest capital of 600,000 kronor, which, in 1916, was increased to 4,200,000 kronor. To begin with, the town of Landskrona placed 84,000 sq. m. of land and sea bottom at the disposal of the company, and this area has subsequently been increased by additional 150,000 sq. m. to 200,000 sq. m. of sea bottom, the company to defray the expense of constructing quays, &c. The shipbuilding proper takes place on an artificial island, where the construction of 4,000-ton to 5,000-ton vessels has been going on for some time, but it is proposed to build ships having a capacity of 12,000 tons. A dry dock, said to be the largest in Scandinavia, is in course of construction and approaching completion. The dimensions are, length 621 ft., breadth 88 ft., depth 26 ft.; the cost, exclusive of dock gates, pumping installation, cranes, &c., amounts to 1,950,000 kronor and a 60-ton crane has cost 300,000 kronor. The dock can accommodate vessels of 15,000 tons. At present there are four steamers in course of construction. As in other Scandinavian towns, an extension of the harbour has been decided upon as a supplement to the shipyard, and it is proposed to enlarge the Landskrona harbour so that it becomes the third in Sweden. (18 kronor = 1*l.* at per value.)

Motor-driven vessels are being more and more generally adopted, thanks in the first instance to the spirited manner in which the East Asiatic Company, of Copenhagen, took up the matter and the excellent results achieved by the Burmeister and Wain Shipbuilding Company. In Sweden, the Nordstjerna Shipping Company followed suit, ordering a number of motor vessels from the Burmeister and Wain yard, and by degrees other companies have adopted the system on an increasing scale. Thus the Olsen Shipping Company, in Christiania, which hitherto went in for traffic in North European ports with moderate-sized steamers, is now building quite a fleet of motor vessels for transoceanic traffic; two boats, one of 9,500 tons and one of 5,500 tons are already trading, a third, of 9,500 tons, is undergoing its trial trips, and a fourth, of 6,500 tons, is approaching completion. The company is building three more motor vessels abroad, making a fleet of seven motor vessels of comparatively large dimensions. A Norwegian owner, Mr. Wilhelmsen, of Tönsberg, has ordered six motor vessels of 6,500 tons each for overseas trade, besides two motor vessels ordered in Holland. The Nordenfjeldske and Bergenske Steamer Company is having two motor vessels built of about 8,000 tons each. Mr. Otto Thorsen, of Christiania, is building one motor vessel of 9,000 tons and Mr. Camillo Fitzen, two motor vessels of 6,000 tons each. This makes a total of 19 good-sized motor vessels built or in process of being built for the Norwegian merchant navy.

Turbine-propelled vessels are also attracting increased attention, and their advocates think they will be the most serious competitors of the motor-driven vessels. In this respect also Norway is well to the fore, and a new type, the so-called Brodin type, was launched the other day from the Frederikstad Shipyard, Norway, it being christened the Arcturus. The dimensions are 300 ft. length, 47 ft. breadth, depth 23 ft., and draught 19 ft. 9 in., 4,600 tons deadweight. The special feature is connected with the location of the ship propelling machinery, the boilers, bunkers and the turbo-electric driving sets—two turbo-generators of 600 i.h.p. each, generating three-phase current—are placed amidships, whilst the motors and gearing are placed aft, the current transmission being by cables. This arrangement ensures a saving in space, resulting in an increased cargo capacity of about 100 tons, in addition to which the consumption of coal is claimed to be smaller, by about 200 tons, than in a vessel propelled by ordinary steam engines. This means a 200-ton deadweight increase in loading capacity. At the trial trip a speed of 11 knots was reached. The consumption of coal was guaranteed at 0·45 kg. best East Coast coal per indicated horse-power per hour, and this condition was fully complied with. The Frederikstad yard has orders in hand for 25 vessels of this type.

The new Baltica yard at Frederiksholm, near Copenhagen, is also going in for the building of turbine vessels, to which end it has entered upon an arrangement with the Atlas Engineering Company, Copenhagen, which well-known establishment has now taken up the manufacture of steam turbines, having secured the assistance of Professor Thomsen, of the Polytechnic College, Copenhagen. The Baltica yard has experienced some trouble in securing the necessary machinery, the German makers raising the prices to a prohibitive extent. Most of the plant has therefore been produced in Denmark. The yard has already secured some half-dozen orders.

At Köge, in Sealand, two yards are being started, one by the well-known and enterprising shipowner, M. Lauritzen, who proposes to build his own vessels, and the Codan yard, which will build wooden and ferro-concrete vessels; the latter material will be more especially applied to the building of standard, motor-driven vessels of 1,250 tons to 1,300 tons. A special system of reinforcement will be adopted, and it is confidently expected, that the weight can be materially reduced. There are three slips for wooden vessels, having capacities of 600 tons and 250 tons deadweight.

At Venö, near Hobro, a new yard has been started with ship accommodation for four vessels, the keel having been laid for two 520-ton wooden schooners, a saw mill being connected with the yard. At Odense, in the island of Fuhnen, the building of a yard has been decided upon.

The Rödby yard, in the island of Lolland, is on a larger scale; keels have been laid for three vessels, a fair quantity of raw materials has recently arrived, and the erection of shops is proceeding satisfactorily, a small town already springing up in connection with the yard. The construction of a neighbouring dry dock is contemplated. From the new Kallundborg yard, in Sealand, two 700-ton motor vessels are about to be launched.

For the first time during the war the Swedish merchant navy has shown an increase, this took place at the end of the second quarter of the present year. Fewer vessels have been lost and the building of tonnage in Sweden is on the increase. During this quarter 25 Swedish-built vessels were registered, having an aggregate tonnage of 19,409 tons gross, a marked increase on the preceding quarter, during which eight vessels aggregating 4,823 tons gross were in hand. During the whole of 1917 39 vessels, having an aggregate tonnage of 20,410 tons, were built. In addition, some vessels have been bought from abroad, mostly sailing vessels and small steamers. It is the general opinion, that if only the raw materials problem could be satisfactorily solved, then Swedish shipbuilding would be still more to the fore. This question, however, gives rise to considerable inconvenience now and to some apprehension as regards the future. England, America and Germany will all need vast quantities of shipbuilding material after the war, and the situation will govern competition in shipbuilding between various countries after the war. German interests are attempting to gain an influence on Swedish shipbuilding, and until Sweden can command home-produced material her interests are likely to suffer in various directions.

The Swedish shipbuilding industry, however, is making rapid strides in the direction of increasing its capacity; and new yards are being erected in a good many towns, both large and medium-sized. The Norrköping yard, which was started in 1917 with a share capital of 650,000 kronor, since increased to 2,000,000 kronor, has already delivered two motor vessels of 700 tons and paid 6 per cent. for 1917. The yard is now being extended so as to be able to build vessels of 3,000 tons.

The new yard of the Stockholm Shipping and Shipbuilding Company at Kimmelriäsviken is now approaching completion; two slips, one for vessels of 1,500 tons, are about ready; the first vessel is a 350-ton sloop for the Baltic trade. A large repair quay is being built alongside of which there will be a depth of 17 ft. of water. Negotiations for the removal to the yard of an engineering shop are pending, and there are prospects of excellent means of communication, both by rail and by water.

A new ferro-concrete building yard is being started in Stockholm under the style of Svenska Betonverken. The capital is from 3,000,000 kronor to 6,000,000 kronor, the new concern is principally, but not exclusively, intended for the building of ferro-concrete vessels. A favourable site has been secured near Södertelje, with good shore conditions, room for slips; gravel and other necessary materials are available and a saw mill is in the vicinity. Able experts have been connected with the new undertaking, and the programme comprises the building of some 20 vessels annually; they will be built to Lloyd's and Veritas' requirements and contracts have already been offered by several shipping concerns.

At the Oscarshamn yard, two cargo steamers of a new design have been ordered; they are to be of 2,000 tons deadweight. These ships are being built as single-deck boats of prime Swedish steel, to Bureau Veritas highest class for the Atlantic trade. The vessels will have an 18-ft. wide and 4-ft. high trunk, continuous fore to aft, with four large hatches. The engines are reciprocating, and the speed will be 10 knots with full load.

The Lysekil yard is contemplating the construction of a large dry dock of 8,000 tons capacity, and the yard will be extended so as to be able to build good-sized steel vessels.

The Lindholmen yard, Sweden, has launched another standard steamer, 3,150 tons deadweight, having engines of 1,160 h.p., and built to highest class, British Lloyd.

Swedish owners have ordered 55 vessels at Norwegian yards, having an aggregate tonnage of 142,000 tons gross, including six large vessels to be fitted with Danish Diesel engines and five with turbo-electric machinery, the turbines being delivered from Sweden. Shortage of materials will greatly retard delivery, and there seems also some doubt as to the Norwegian Government being willing to give the necessary permission for export. Swedish owners are still worse off as regards their orders at Dutch yards, Germany having refused to supply materials for the vessels ordered for Sweden, probably on account of Sweden's tonnage arrangement with the Entente. The shortage of materials in Norway is making itself more and more felt, and almost all the yards have had materially to reduce their number of employees and the activity in various departments; at several yards the work on new vessels has had to be discontinued from lack of angle iron and steel plates. The Norwegian authorities applied to Sweden for help, so as to avert a complete stoppage, and it is understood that Sweden has promised to supply 4,000 tons of plates. Norway is also negotiating with the English authorities.

Among the Swedish shipping firms, combines are being formed; the large Transatlantic Company has secured a majority of shares of the Neptunus Company, Helsingborg, which company obtained 7,000,000 kronor for its three steamers, whilst the share capital only amounted to 1,000,000 kronor. A new shipping company has been started in Helsingborg, having a share capital of 1,500,000 kronor. Excessively high prices are on record from Sweden; thus a 2,000-ton steamer was sold to that country for 1,200 kronor per ton deadweight, and the Norwegian steamer Anne Moore, 2,300 tons, was sold for 1,350 kronor per ton.

A new Norwegian American shipping company has been formed by shipowners in the two countries. The new concern is registered in America under the style of the American Liberty Steamship Line Corporation, with headquarters at Seattle, from whence the company's vessels will trade to China and the East Indian islands, Batavia, the Philippines, Australia and New Zealand. Eight wooden vessels will be placed in service as soon as possible, four of which are already finished and the others are being built on the American West Coast. As soon as possible it is intended also to traffic with steel vessels.

CATALOGUES.

Electric Rail Connections.—Messrs. Grammont, 220 Route d'Heyrieux, Lyon, France, send a copy of their French catalogue on rail connections for transmitting the current from one length of rail to another. Various types are fully and clearly illustrated and dimensioned.

Boiler-House Plant.—The removal of ash and clinkers by pneumatic and steam suction, elevators and hoists is discussed on practical lines, with illustrations, in a periodical entitled "Cheap Steam," issued by Messrs. Ed. Bennis and Co., Limited, Bolton.

Building Construction.—Examples of steel, and wood and steel, members for erecting factories, detached halls or mess rooms, stairs, fences, ventilators, &c., are given in a catalogue from Messrs. David Rowell and Co., Limited, 14, Howick-place, S.W. 1. In this system a roof, fence, stair or complete building is sent out ready for rapid erection.

Heat Treatment.—A further contribution to this now engrossing subject is contained in a catalogue received from Automatic and Electric Furnaces, Limited, 6, Old Queen-street, S.W. 1. It deals with the heat treatment of frictional wearing parts, saws, magnets and screw gauges. Advantages are claimed for salt bath quenching with the use of the Wild-Barfield furnace and pyroscopic detector. Some test figures are given and the writing is on practical lines.

Railway Truck Unloaders.—Two types of truck unloaders are shown in a special catalogue received from Messrs. Ed. Bennis and Co., Limited, Bolton. The first is a revolving framework which tips the truck over for emptying from the side; the second holds the truck securely while a ram lifts one end and discharges the contents from the other end. Both are substantially built and are illustrated with the general conveying machinery of which they would usually form a part.

Acetylene Gas Generation.—Portable generating plants are described in a catalogue issued by the Acetylene Corporation, Limited, 49, Victoria-street, S.W. 1. Various convenient sizes are made with trolley and stand mountings and fittings for welding and cutting. The parts are clearly shown and explained, and complete outfits listed and offered, with practical advice on calculating the capacity, &c., required. These fittings are for the low-pressure system.

Electric Switch Gear.—Oil-break switches and panels, truck switch gear, tension limiters and lightning arresters, limiting resistances, choking coils, isolating links, insulated long arms, high-tension plug fittings, underground boxes, time-limit relays and fuses, reverse power relays and static leakage detectors are dealt with in a catalogue received from the General Electric Company, Limited, Queen Victoria-street, E.C. 4. Illustrations are given in all cases, with carefully-stated dimensions, capacities and such other particulars as are required. A number of dimensioned line drawings are also printed.

Repeated Impact Testing.—A machine for making breaking tests on steel bar is described in a catalogue received from the Foster Instrument Company, Letchworth. A large number of blows, for instance about 1,000 blows on a 0·4 in. diameter, are delivered at a rate of 60 to 90 blows per minute. The test-piece is revolved half a turn after each blow. A circular breaking groove is recommended. The test reveals a different quality in the metal from that shown by a single impact break, and it is claimed that the total force can be accurately measured. Test figures are given, and the principles of the machine fully explained. The method of testing meets, in a large measure, recent criticism, and makes some approach to discovering what has been called the fatigue strength.

Marine Coil-Tube Work.—The Griscom-Russell Company, 90, West-street, New York, send a handsomely-printed and bound catalogue of fittings for evaporating, distilling, boiler-feed water heating, oil heating and cooling, and water heating and filtering for general use on board ship. The essential part of this work is the making of coiled tubes and joints and the methods of fixing into variously designed chambers. In nearly all cases 16-gauge tube is used, mostly 1 in. diameter, sometimes $\frac{3}{4}$ in. and $\frac{7}{8}$ in. Only seamless drawn tube is used. The material is chiefly brass, with copper or steel in certain cases. The coils are closely wound to a small diameter. The joints are made by flanging back the tube-end so far that the flange is at an angle of about 45 deg. from the tube. The flanges are two-hole open-end S-shape for making quick connections. A great deal of consideration has been given to making the various systems easily open to inspection, cleaning and repair. The catalogue is especially interesting as in this class of work, as in boiler making, British engineers have always maintained a distinct supremacy over all other nations. The Griscom-Russell firm, which has a fifty years' record, state that this is the first bound catalogue issued including all their work. It gives unmistakable evidence of careful design with full regard to practical requirements.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

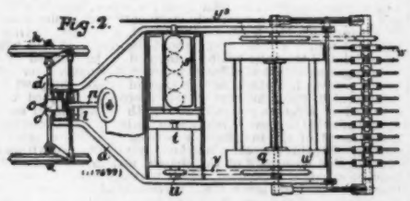
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

AGRICULTURAL APPLIANCES.

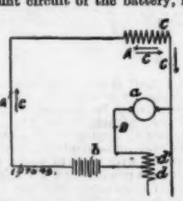
117,699. J. H. Pick, Stamford. Motor Tractors. (3 *Figs.*) August 7, 1917.—This invention relates to motor tractors for use in connection with agricultural tilling implements. A tractor constructed according to this invention has a chassis or frame *a* having at the front a pair of steering wheels *h* and at the rear an open drum wheel which is mounted on a fixed axle extending across the chassis. The motor *s* and change-gear box are mounted transversely of the chassis *a* at or about the centre of the length of the latter, the driven shaft of the change-speed gear *t* being directly geared to the drum wheel *q* by sprocket wheels *u*, *u*1, and a chain *v*. The front steering wheels *h* are carried upon stub-axles having vertical standards housed in brackets fixed to an axletree *d*; this axletree is not rigid with



relation to the chassis, but is provided with a central boss or fitting *o*, through which a horizontal king-pin or stud *c* projects. The steering is effected by means of a hand wheel, the spindle *n* carrying which has a bearing in an extension upon the said central boss or fitting *o*, the said spindle having upon it a pinion *m*, which engages with a rack *l*, the extremities of which are connected to levers on the upper ends of the stub-axle standards. Sometimes there is combined with the tractor a rotating digger *w*, and to adjust the height of the said digger with relation to the ground and also the depth at which it will work, a lever y^3 extending to a position adjacent to the driver's seat is provided. (Sealed.)

ELECTRICAL APPARATUS.

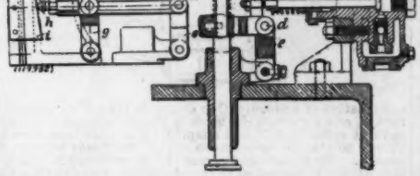
117,849. A. H. Midgley and C. A. Vandervell and Co., Limited, Warple Way, Acton Vale. Self-Regulating Dynamos. (3 *Figs.*) August 4, 1917.—This invention relates to a self-regulating continuous current dynamo of the kind in which a field excitation winding in series with an independent source of current is arranged in parallel with the brushes of the dynamo for the purpose of producing a current of constant voltage independently of the speed or load of the machine. The dynamo constructed according to the present invention is provided with a shunt and with a series field winding, the shunt winding being arranged in series with a battery and the series winding or a portion thereof being included in or entirely excluded from the said shunt circuit, and the arrangement being such that when the series winding is energised by the load current its excitation assists in building up the field in the same direction as the shunt winding when the latter is supplied with current from the battery. In the arrangement illustrated diagrammatically, the shunt circuit of the battery, including the shunt



winding, also includes a portion of the series winding, the battery being preferably connected to approximately the middle of the series winding, *a* is the armature, *b* the battery, *c* the shunt winding and *d* the series winding of the machine, the battery *b* being arranged in series with the shunt winding *c* and with the portion *d*1 of the series winding *d*, all of them being arranged in parallel with the armature *a*. The operation of the arrangement described is as follows: At low speeds and no load the battery *b* discharges through the shunt winding *c*, through the portion *d*1 of the series winding *d* and through the armature *a*, the current passing through the portion *d*1 of the series winding in the direction of the arrow A. The battery and the dynamo are connected in such a manner that they act in opposition to each other, as indicated by the arrows A and B respectively, the consequence being that the shunt winding *c* is excited by the difference in voltage between the voltage of the dynamo and that of the battery. As the speed increases the dynamo voltage tends to increase, thereby reducing the shunt current. When the load is connected to the machine the battery current flowing through the shunt winding *c* passes through the other portion of the series winding *d*, assisting the shunt winding *c*. At the same time, owing to the decrease in voltage across the armature due to the closing of the main circuit; the voltage opposed to the battery *b* is smaller and consequently a greater current flows through the shunt winding *c* in the direction of the arrow A. As the speed increases the shunt current gradually decreases owing to the increase of the current in the direction of the arrow B until it becomes zero at a certain speed, the field being now maintained only by the series winding *d*. On further increase of the speed while the machine is under the load the current through the series winding increases and the voltage acting in opposition to the battery is now greater than the voltage of the latter and consequently a charging current flows through the battery and in an opposite direction through the shunt winding, as indicated by the dotted arrow C, so that the latter winding now acts in opposition to the series winding. (*Accepted August* 14, 1918.)

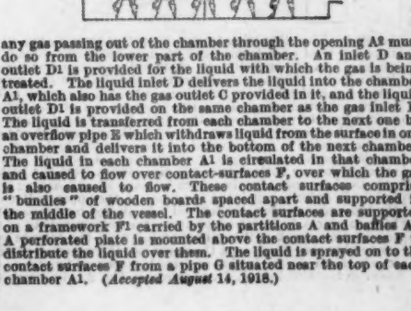
GAS ENGINES, PRODUCERS, HOLDERS, &c.

117,782. T. H. Gardner and E. Gardner, Patricroft. Internal-Combustion Engines. (5 *Figs.*) October 26, 1917.—This invention relates to the liquid fuel supply arrangements of internal-combustion engines. The invention comprises a liquid fuel pump operated by a bell-crank lever from a part having a uniform back and forth movement, the said lever being fulcrummed about a movable point, the position of which is determined by the engine governor, so that a period of lost motion of variable extent can intervene between the commencement of movement of the bell-crank lever and the period of engagement of the pump piston or plunger by said lever. The fuel pump is operated by one arm of a bell crank lever *b*, the other arm of which is engaged by a part, such as the engine inlet valve tappet *c*, having a uniform back and forth movement. The plunger is



held in its extreme position by the spring *a*1, which forces the head *a*2 against the pump casing, as shown. The fulcrum *d* of the bell-crank lever *b* is carried by a swinging link *e* connected by a connecting rod *f* to a second swinging link *g*; the end of said connecting rod having a nose-like extension A thereon which is adapted to engage a wedgelike part *i* (hereinafter termed a striking plate) adjustable in position by the engine governor. With this arrangement, the bell-crank lever *b* is given oscillatory movements about its fulcrum *d*, but the amount of movement imparted to the pump depends upon the position of the striking plate *i*, and therefore of the lever fulcrum *d*, which determines the amount of lost motion the bell-crank lever *b* may have before it engages the pump plunger *a*. (Sealed.)

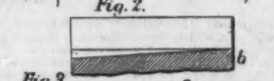
117,843. N. Wilton, Hendon, and The Chemical Engineering and Wilton's Patent Furnace Company, Limited, Hendon. Gas Manufacture. (2 *Figs.*) July 31, 1917.—This invention relates to apparatus for treating coal gas with water for the extraction of ammonia, or for treating it with oil for the extraction of benzol. The type of apparatus to which this invention is applied comprises a series of chambers through which successively the gas flows in one direction and the liquid in the opposite direction, and means whereby the liquid in each chamber is circulated over contact surfaces therein to bring it into contact with the gas. According to this invention, each of the chambers is provided with means for directing the flow of gas so that it flows over the contact surfaces in the chamber always in the same direction as the liquid flows over them. The apparatus comprises a structure provided with partitions A to form a number of separate chambers A1. B is a gas inlet and C a gas outlet. Each partition has an opening A2 near the top, and each chamber A1 has a baffle A3 extending from the top down past the opening A2 towards the bottom of the chamber, so that

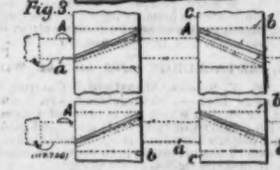


any gas passing out of the chamber through the opening A2 must do so from the lower part of the chamber. An inlet D and outlet D1 is provided for the liquid with which the gas is being treated. The liquid inlet D delivers the liquid into the chamber A1, which also has the gas outlet C provided in it, and the liquid outlet D1 is provided on the same chamber as the gas inlet B. The liquid is transferred from each chamber to the next one by an overflow pipe E which withdraws liquid from the surface in one chamber and delivers it into the bottom of the next chamber. The liquid in each chamber A1 is circulated in that chamber and caused to flow over contact-surfaces F, over which the gas is also caused to flow. These contact surfaces comprise "bundles" of wooden boards spaced apart and supported in the middle of the vessel. The contact surfaces are supported on a framework F1 carried by the partitions A and baffles A3. A perforated plate is mounted above the contact surfaces F to distribute the liquid over them. The liquid is sprayed on to the contact surfaces F from a pipe G situated near the top of each chamber A1. (*Accepted August* 14, 1918.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

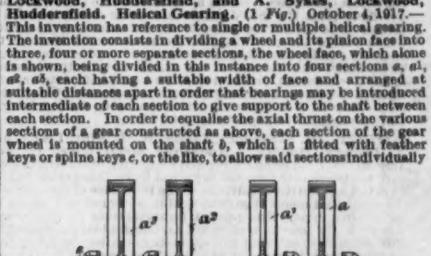
117,738. David Brown and Sons (Huddersfield), Limited, Lockwood, Huddersfield, and A. Sykes, Lockwood, Huddersfield. Helical Gearing. (4 *Figs.*) October 4, 1917.—This invention relates to high-speed gearing. *a* represents the pinion shaft which, together with the pinions *b*, *b*, mounted thereon, are shown in dotted lines occupying a position in front of the gear wheels *c*, *c*, with which they are in mesh. The pinion shaft *a*, when under load, is deflected torsionally and also transversely, by reason of the elasticity of the metal and similar deflection also takes place in the gear wheels *c*, *c*, and their shaft. The effect of such deflection in double helical gears, shown in the figures, is that assuming the wheel and pinion to be fixed axially with relation to each other, the whole of the load of the teeth would come at one end thereof, namely, the end A nearest the source of power, and there would be between the teeth of the pinions and the teeth of the gear wheels a gradually increasing or widening opening extending therefrom towards the opposite ends of the teeth, as illustrated in an exaggerated manner in Fig. 4, the pinion shaft *a* being assumed to be rotating in the





direction of the arrow. If the wheels or pinions be allowed to slide or float axially for a short distance, one wheel or half of the wheel having its teeth cut right hand and the other half left hand as shown, the teeth of the wheel and pinions will occupy such relative positions after adjustment that the total load on each half of the gear will be equal but concentrated on one side of each half of the gear, there being only a slight opening at a point removed from the driving side A, as indicated in Fig. 4. In order to eliminate the effect of the torsional deflection the improved construction of pinions and gear wheels shown in Figs. 1 and 2 is provided. The invention consists in cutting at the bottom of the spaces between the teeth of the pinions or wheels *c* or both pinions and wheels, grooves *e* at the driving side A of the gears, and inclining upwardly therefrom to the opposite side of the tooth space, where they merge in the ordinary bases or bottoms of the tooth spaces, the said grooves thus being gradually reduced in depth towards the points where there would tend to be an opening between the opposing surfaces of the teeth in mesh. (*Accepted August* 8, 1918.)

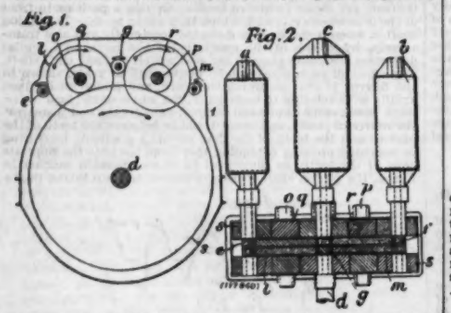
117,739. David Brown and Sons (Huddersfield), Limited, Lockwood, Huddersfield, and A. Sykes, Lockwood, Huddersfield. Helical Gearing. (1 *Fig.*) October 4, 1917.—This invention has reference to single or multiple helical gearing. The invention consists in dividing a wheel and its pinion face into three, four or more separate sections, the wheel face, which alone is shown, being divided in this instance into four sections *a*, *a*1, *a*2, *a*3, each having a suitable width of face and arranged at suitable distances apart in order that bearings may be introduced intermediate of each section to give support to the shaft between each section. In order to equalise the axial thrust on the various sections of a gear constructed as above, each section of the gear wheel is mounted on the shaft *b*, which is fitted with feather keys or spline keys *c*, or the like, to allow said sections individually



to slide axially on the shaft *b* for a short distance. On the side of each section *a*, *a*1, *a*2, *a*3, towards which the axial thrust is directed, there is mounted on the shaft *b* a collar *d* which is provided with chambers or cylinders *e*, in which are located plungers *f* adapted to be forced or held in an outward position by hydraulic pressure. The total axial pressure exerted by the plungers on the respective wheel sections being equal, any deflection occurring on any wheel section tending to increase the load on said section will cause it to slide axially on the shaft for a short distance and thus force its respective plunger inwardly against the hydraulic pressure, the displacement of the liquid acting with increased force on the plunger engaging the next succeeding wheel section, this being continued if called for in connection with each wheel section until equilibrium is re-established. (*Accepted August* 8, 1918.)

117,840 The Hon. Sir C. A. Parsons, S. S. Cook, and L. M. Douglas, Newcastle-on-Tyne. Gear Trains. (6 *Figs.*) July 20, 1917.—The invention relates to gear trains for transmitting power through reduction or augmentation gearing to a driven shaft, of the type in which one or more of the primary pinions drives two primary gear wheels mounted on intermediate shafts which carry secondary pinions engaging with a main gear wheel, the gears being all of the double helical type and symmetrically disposed about a central plane. The invention consists in a multiple reduction or augmentation gear train in which one or more of the primary pinions drives two primary gear wheels mounted on intermediate shafts carrying secondary pinions which engage with a main gear wheel, the gears being all double helical and symmetrically disposed about a plane through the driven shaft, while the intermediate shafts are so disposed

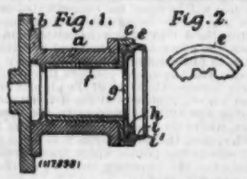
or balanced that the resultant line of force on each intermediate shaft coincides with the centre of gravity of the intermediate shaft. A high-pressure turbine *a*, intermediate pressure turbine *b* and low-pressure turbine *c* are arranged to drive the shaft *d* through double reduction gearing. The installation is symmetrical about the vertical plane through the axis of the shaft *d*. The shafts of the turbines *a*, *b*, *c*, carry respectively primary



pinions *e*, *f*, *g*, which drive primary gear wheels *l*, *m*, on intermediate shafts *o*, *p*, which carry secondary pinions *q*, *r*, driving a secondary gear wheel *s* on the driven shaft *d*. The primary pinion *g* drives both the primary gear wheels *l*, *m*, which are also driven by the primary pinions *e*, *f*, disposed substantially diametrically opposite the primary pinion *g*. The centre pinion *g* preferably transmits twice as great a force as either of the other two primary pinions *e*, *f*. (*Accepted August* 14, 1918.)

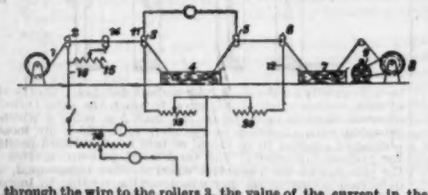
MINING, METALLURGY AND METAL WORKING.

117,898. F. W. Stokes, Mansfield. Casting Machines. (2 *Figs.*) June 22, 1917.—This invention has reference to casting machines of the kind in which use is made of a rotating mould furnished with a hinged or removable door, and into which the metal or other material to be cast is introduced through a pourer. The chief object of the invention is to provide a construction of door which enables the thickness of the casting to be regulated. *a* indicates the mould which is secured to the faceplate *b*. *c* is the door and *e* is a plate with which the door is furnished and the object of which is to regulate the thickness of the casting *f*. This is effected by providing the plate *e* with the central aperture *g*, the diameter of which determines the thickness. In the



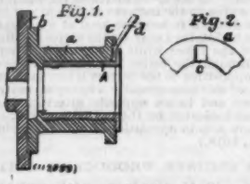
construction shown, the inner periphery of the plate *e* is formed of a serrated or undulating shape, as clearly shown in Fig. 2, the object of this construction being to break up the metal which overflows from the mould *a* into a number of small strips or pieces. *h* is the curved shape of the outer face of the plate *e* which causes the metal ejected from the mould through the aperture *g* in the plate *e* to pass laterally instead of in a straight line parallel with the axis of the mould, and *i* is the lip which forms a channel *i*1 for receiving the pieces of metal ejected through the plate *e* and along the curved surface *h*. The plate *e* may either be a separate integer or it may be formed integral with the door *c*. (*Accepted August* 14, 1918.)

117,822. H. Alexander, Leeds, W. T. Vint, Leeds, and A. Imbery, Halifax. Annealing Metal Wire. (1 *Fig.*) July 20, 1917.—The annealing and tempering of travelling metal wire has previously been accomplished by its being made to form a part of an electric circuit, the ohmic resistance of the wire with the requisite amount of current flowing, automatically producing the desired heat. The present improvements in this process consist in the provision of means for the gradual heating of the wire when first entering the apparatus or after emerging from a cooling bath therein, or at both these stages of the process. The wire 1 is passed between a pair of rollers 2, thence to another pair of rollers 14 and a third pair 3, then through an oil-cooling bath 4, then between two more pairs of rollers 5, 6, through another cooling bath 7, and on to a drum 8 driven by a motor 9. The alternating current is carried by an insulated cable 16 to a suitable contact stud attached to one of the rollers 2, whence it flows



through the wire to the rollers 3, the value of the current in the wire being adjusted by means of a variable resistance 10 in series with the main supply. An adjustable resistance 15 is connected from the supply lead 16 to the intermediate rollers 14, so that any desired current value can be obtained in the part of the wire first entering the apparatus. Between the rollers 3 and 5 the wire is short-circuited by a heavy copper lead 11, so that in passing through the cooling bath 4 the wire is no longer heated. Between the rollers 5 and 6, the wire is again heated, but after passing the rollers 6 the current is again taken off by the copper lead 12. Additional control resistances are provided at 13 and 20. The use of additional rollers and an adjustable resistance may also be found desirable between the pairs of rollers 5 and 6 which are normally the third and fourth pairs in the apparatus and similarly where six, eight or other number of pairs of rollers are normally employed. (*Accepted August* 14, 1918.)

117,899. F. W. Stokes, Mansfield. Casting Machines. (2 *Figs.*) June 22, 1917.—This invention relates to centrifugal casting machines of the kind designed to produce castings which are flanged at one end only, and it has for its object to provide means for facilitating the withdrawal of the finished casting from the mould. According to the invention, a recess is provided in the outer end of the mould, the said recess being adapted to be filled with sand before the mould is rotated. After the casting has been made and the door of the mould opened, a lever may be inserted into the recess behind the flange and the casting, and thus be used for pushing the casting from the mould. *a* indicates the mould which is secured in the ordinary way to the face plate *b* and is of the kind designed for the production of a

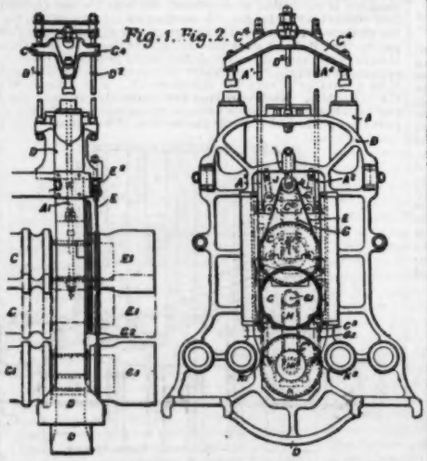


casting A with a flange at one end. The mould *a* is made with a recess *c* which is filled with sand before the mould is rotated and the metal introduced into it, so that after the casting has been made and the door, which is not shown in the drawings, removed, a lever, such as is shown at *d*, in Fig. 1, can be inserted into the recess *c* behind the flange of the casting A and be manipulated so as to lever the latter forward out of the mould. (*Accepted August* 14, 1918.)

117,871. The Standard Motor Company, Limited, Foleshill, Coventry, and J. W. Hickman, Foleshill, Coventry. Metal-Working Tool. (2 *Figs.*) November 6, 1917.—This invention relates to tools for forming a bead or hollow turned-over edge at the end of a metal tube. The tube end to be treated is first provided with an outwardly-directed flange which may be produced in any suitable manner, after which the bead is formed by the tool forming the subject of this invention. According to this invention, the tool comprises the

combination of a mandrel C to engage in the end of the flanged tube A, and a grooved die block D hinged to the mandrel by a resilient connection E and adapted to be adjustably clamped thereto so that the groove can engage the flange to form the bead B. The bead forming groove in the die block is so shaped that when it is pressed on to the edge of the flange and the tube is rotated, the flange is caused to roll over; after which the clamp is tightened and the operation repeated until the bead is complete. The die block instead of being resiliently hinged to the mandrel can be pivoted thereto. (*Accepted August* 14, 1918.)

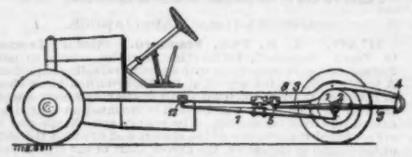
117,863. Duncan Stewart and Co., Limited, Glasgow, and T. E. Holmes, Glasgow, Rolling Mills. (2 *Figs.*) October 11, 1917.—The invention relates to two-high rolling mills fitted with usual hydraulic balance gear. According to the invention, there are provided a series of slings of wire rope or the like coacting with shackles on the housing and the coupling pieces and pintie ends of the rolls, and links coacting with anchorages thereon and on the chocks, in combination with detachable collar and cottar or like devices on the usual connecting rods of the hydraulic balance and lifting gear. The mill is provided with the usual hydraulic balance and lifting gear A. This gear is connected by rods A1, A2, with the upper and bottom parts C2, C3, of the bearing chock for the upper roll C, the crosshead C4 of the hydraulic gear sliding on stationary guide rolls D1, D2, extending up from the mill housing D. Two wire rope slings for each roll C, C1, are also provided. The sling E for one end of the upper roll C is of such length that it may be passed round the coupling-piece E1 of that roll and a shackle E2 on the



housing. The other sling (shown by dotted lines G, Fig. 2) for that roll is of such length that it may be passed round the pintle G1 on the opposite end of the roll and a similar shackle (not shown). For the bottom roll C1 the sling G2 for one end may be passed round the coupling-piece G3 of the upper roll C, whilst the other sling H for the opposite end of the bottom roll C1 may be passed round the pintle H1 of that roll and the pintle G1 of the upper roll C. Links J, J1, anchored at one end on the housing D are provided to carry the top half C2 of the bearing chock, for the upper roll, when raised, and the bearing chock K for the bottom roll C1 is also carried from the bottom part C3 of the upper bearing chock by links K1, K2, having hook ends. In order to repair the top brass of the upper half C2 of the top bearing chock, the top roll C is lowered by means of the balance gear A to its lowest position, the bottom half C3 of the top bearing chock is then disconnected from the balance gear connecting rods A1, A2, and the upper half C2 connected to these rods is raised clear. In that position it is secured by pins to the lower end of the links J, J1, as shown in Fig. 2. To repair the bottom half C3 of the same chock, the top roll C is raised by the balance gear and the slings E, G, passed round the coupling-piece E1, pintle G1, and shackles E2, as hereinbefore described, and as shown in the drawings. The lower half C3 of the upper chock may then be lowered by the balance gear, while the roll C remains suspended by the slings E, G. To obtain access to the bottom roll chock K, the upper roll C is lowered until the slings G2, H, may be passed round the coupling pieces G3, E1, and pintles G1, H1, then, on disconnecting the links K1, K2, both rolls C, C1, may be raised by the balance gear and the bottom chock K left exposed. (*Accepted August* 14, 1918.)

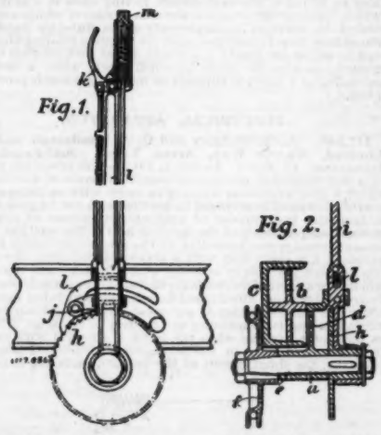
MOTOR ROAD VEHICLES.

115,831. Lancia and Co., Turin, Italy. Spring Suspension. (2 *Figs.*) May 12, 1917.—This invention consists in a spring suspension for motor vehicles provided with an ordinary semi-elliptical spring to the middle portion of which is pivoted the rear of the vehicle, and a laminated spring pivoted at its middle portion to the vehicle frame and having one of its ends connected with said frame and the other connected with the vehicle rear axle. Each end of the rear axle 1 of the vehicle passes through a sleeve 2, to which are connected the laminated



spring sections 3, 3, connected at 4 and 5 with the vehicle frame and constituting an ordinary semi-elliptical spring. To the sleeve 2 there is connected on end of a laminated spring 7 which is pivoted at its middle portion to the frame 8; the opposite end of said spring being connected with the frame 12. The resiliency of the several springs is arranged to give the total resiliency desired. By means of this system a spring suspension is obtained which combines the satisfactory operation of cantilever springs with that of the ordinary semi-elliptical springs. (*Accepted August* 14, 1918.)

117,850. The Birmingham and Midland Counties Transport Company, Limited, Birmingham, and G. E. D. Ralls, Birmingham. Brake Mechanism. (2 *Figs.*) August 7, 1917.—This invention relates to brake mechanism for vehicles, of the type in which a wheel is adapted to be rotated by a lever pivoted coaxially therewith, and carrying a tooth adapted to engage with teeth upon the wheel, and in which a pawl mounted upon a relatively stationary part is also adapted to engage with the teeth on the wheel, said pawl having an extended tail, which is curved about the centre of said wheel, by which tail the pawl has been adapted to be released by the lever engaging with it at different points in its length. According to the present invention, in this type of brake, the pawl is so incorporated that the curved tail thereof is adapted to be actuated at different points in its length by a member carried by and adapted to move in relation to the lever. In a convenient embodiment of the invention a bearing is installed upon the chassis. For this purpose a bracket *b* is incorporated within the channel side element *c* of the chassis, and in relation to said bracket a part *d* is secured, which part *d* carries a transverse boss *a* at a position below the side element of the chassis. The boss carries a transverse shaft *e* to the one extremity of which is keyed a grooved pulley *f*. Within the groove of this pulley one extremity of a wire rope is secured so that the rope may be wound within the groove of the pulley. At or near its other extremity the shaft has keyed to it a toothed wheel *h*. Pivotally



mounted upon the shaft is the operating lever *i*. This lever is furnished with a pawl *j* adapted to engage with the toothed wheel *h*. The pawl may be released by a lever *k* associated with the top of the operating lever through a longitudinally moving rod, and thus by appropriately displacing the operating lever the toothed wheel can be displaced therewith in the direction necessary to pull the wire rope in order to apply the brake. The part *d* also carries a pawl *l* adapted to engage with the toothed wheel *h*. This pawl is adapted to retain the toothed wheel *h* from rearward movement after it has been advanced by the operating lever. The direction of movement of the operating lever can be reversed and subsequent rotary movement in the one direction can be imparted to the toothed wheel by oscillating the operating lever. The brake can thus be applied to any desired degree and retained in its applied condition. The pawl *l* is released by a part carried by the operating lever, and this release is adapted to effectively take place with the operating lever in any of the positions which it may assume. For this purpose the operating lever is furnished with a plunger *m* adapted to be depressed by the thumb, and associated with a rod which is adapted to bear upon the tail of the pawl *l*. The tail is elongated, and it is curved about the centre of movement of the operating lever. It is thus possible to release the pawl in any of the positions of oscillation which the operating lever may assume and by also releasing the pawl *j* by the lever *k*, the ratchet wheel *h* is enabled to revolve in the direction necessary to release the brake without any movement being imparted to the operating lever *i*. (*Accepted August* 14, 1918.)